DOCUMENT RESUME

ED 022 849

VT 002 778

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INDUSTRIAL ARTS; A GUIDE FOR COLORADO SCHOOLS.

Colorado State Dept. of Education, Denver. Div. of Elementary and Secondary Education.

Pub Date Apr 66

Note-215p.

Available from-Office of Instructional Services, Division of Elementary and Secondary Education, Colorado State Department of Education, Denver 80203 ($2.50).

EDRS Price MF-$1.00 HC-$8.68

Descriptors-*CURRICULUM GUIDES, ELEMENTARY SCHOOLS, HIGH SCHOOLS, *INDUSTRIAL ARTS, *PROGRAM GUIDES

This program guide is for teacher use in planning and operating a local industrial arts program. It was developed by a committee of the Colorado Industrial Arts Association. The guide presents major concepts and information for a comprehensive program of elementary and secondary industrial arts, and it suggests a variety of educational activities and methods. Major chapters are (1) The Place of Industrial Arts in the General Education Programs, (2) Organization and Administration in the Industrial Arts Classroom, (3) Shop Planning and Maintenance, (4) Safety and Liability, (5) Fundamentals of Design, (6) Student Evaluation, (7) Historic Background and Current Trends in Industrial Arts Education, (8) The General Shop, (9) General Crafts, (12) Mechanical Drafting, (13) General Metals, (14) Power Mechanics, and (15) Woodworking. Most chapters include information, content outlines, photographs of facilities or projects, and an extensive bibliography of references. (EM)

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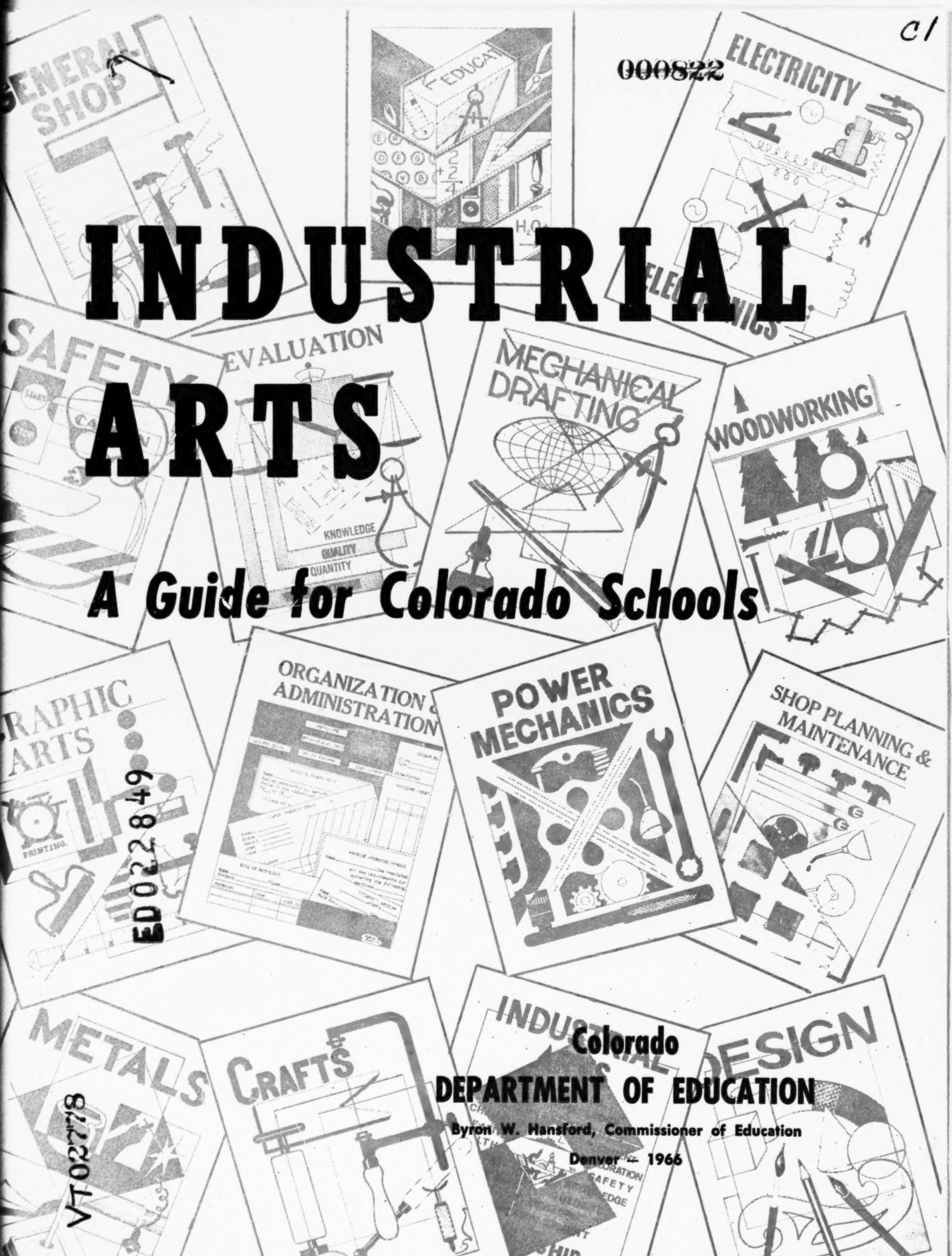
GENERAL SHOP
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KNOWLEDGE
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WOODWORKING
GRAPHIC ARTS
PRINTING
ORGANIZATION & ADMINISTRATION
POWER MECHANICS
SHOP PLANNING & MAINTENANCE
METALS
CRAFTS
INDUSTRIAL
DESIGN

INDUSTRIAL ARTS

A Guide for Colorado Schools

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VT02778

Colorado
DEPARTMENT OF EDUCATION
Byron W. Hansford, Commissioner of Education
Denver — 1966

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INDUSTRIAL ARTS

A Guide for Colorado Schools

Prepared and published
with the cooperation of the
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COLORADO STATE DEPARTMENT OF EDUCATION

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Division of Elementary and Secondary Education
Raymond A. McGuire, Director

Denver, Colorado

April 1966

Price — $2.50
No charge for Colorado School Districts

FOREWORD

Experiences which will provide our youth with an understanding of the highly industrialized society in which we live are a vital part of a comprehensive school curriculum. While the insights developed through the industrial arts curriculum may lead to the desire for specialized vocational education on the part of some children, the broader concepts, skills, work habits, and understandings developed are beneficial to all children and should be an integral part of the general education program.

This guide presents some major concepts in the several areas of a comprehensive industrial arts program and suggests a variety of activities and methods by which these concepts might be taught.

We are indebted to the many groups and individuals who helped prepare this guide. Special commendation should go to the Colorado Industrial Arts Association and Dr. William R. Erwin, Jr., CIAA General Chairman for the guide.

Byron W. Hansford
Commissioner of Education

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ACKNOWLEDGEMENTS

In 1958, the Executive Committee of the Colorado Industrial Arts Association, composed of A. N. Shaw, President, Grand Junction, William R. Erwin, Jr., Vice President, Greeley, and Jess Schmitt, Secretary-Treasurer, Westminster, proposed the production of a guide in Industrial Arts. An Outline was prepared and submitted to Industrial Arts teachers for criticism and suggestions.

Mr. Shaw requested assistance from the State Department of Education. Dr. Clifford Bebell, Director of the Division of Elementary and Secondary Education, and William L. Miller, Head of the Section on Secondary Education, represented the Department in the development of the Guide. One of Mr. Shaw's last official acts as President of the Colorado Industrial Arts Association was the appointment of the various production committees.

Mr. Sherwin D. Powell of Colorado Springs, the incoming President, continued emphasis on the project. The appointed committees worked diligently for completion of the Guide. The dedication of these people, who gave freely of their time and travel at their own expense, is evidence of the highest quality of professional responsibility.

Following the development of the first draft, editorial responsibility was assigned to William R. Erwin, Jr., of Colorado State College. He reviewed the work on production committees and brought the Guide to a state of unity and format for experimental distribution.

The guide was published in mimeographed form for trial use in Colorado schools. Suggestions, reactions, and criticisms were asked for. A second committee was formed to evaluate the suggestions and criticisms and to make the final revision of the guide for publication in final printed form.

Acknowledgment and appreciation on behalf of the Colorado Industrial Arts Association and the State Guide Committee is expressed to Max Hoover, an industrial arts student at Colorado State College, for the development of the illustrations used in the guide.

The names of those who cooperated in revision of the guide are listed on the preceding pages.

INDUSTRIAL ARTS

BASIC SKILLS
BASIC KNOWLEDGE
BASIC TECHNIQUES
CHARACTER DEVELOPMENT
CREATIVITY EXPLORATION
HEALTH SAFETY
CONSUMER KNOWLEDGE
VOCATIONAL GUIDANCE
SOCIAL-CIVIC DEVELOPMENT
ECONOMIC DEVELOPMENT

CITIZENSHIP

CHAPTER I

INTRODUCTION

Purpose of the Guide

The purpose of this guide is to assist the industrial arts education teacher to do a more effective job of teaching. It is especially prepared for the new teacher as an aid in selecting areas of work and developing courses of study. It should also prove useful to the experienced teacher as a guide for evaluation of those courses they are currently teaching, and to assist the administrator in evaluating his industrial arts program.

Surrounded as we are with mechanical devices dominating our entire lives, and recognizing that the development of hand and power tools has been responsible for our highly industralized economy with the highest standard of living in the world, provisions should be made for industrial arts education experiences for all youth. Through these experiences, youth develop an understanding of the *place of industry* in our modern society.

Under our democratic educational philosophy of equal opportunity for every individual, each student should be given the chance to work to his or her full potential. Industrial arts education has a vital role to play in providing this opportunity for efficiency in our society. Every possible effort must be made to offer such a variety of areas of endeavor that each individual's own interests, needs, and abilities may be fully developed. Industrial arts education, as a part of general education, does provide this necessary opportunity for a great many of our youth to adjust successfully to our complex modern environment.

While the contents of this guide are comprehensive, it should be understood that improvements may be necessary and beneficial as time goes on. After completing a review of this guide, it is hoped that each teacher will be motivated to strive for the best and most complete program possible in industrial arts education. It is realized that many plant facilities cannot accommodate an extensive or comprehensive program. Yet the teacher should strive for as complete and up-to-date a program as is practical and possible. It should be recognized that an industrial arts program offering only one area is inadequate.

The industrial arts education teacher or any other classroom teacher is encouraged to make adaptations of the guide to fit his or her needs. The wealth of information in this guide will provide the resourceful teacher with a great many new or forgotten ideas which should enable him to improve his industrial arts education program. The following points may be kept in mind as this guide is studied and used:

1. Use any material that will fit. Adapt that which is not directly applicable.
2. The several course outlines should be studied to give the teacher a broader concept of industrial arts education.
3. For the *purpose of revision,* new ideas should be jotted down and submitted to persons designated to work on revisions.
4. This is only a suggested guide so changes should be made to fit local needs.

Definition of Terms

The definitions of terms are for the purpose of clarification and to prevent misinterpretation of these terms as used in this guide.

General Education	Although general education cannot be defined in a single brief statement, for the purpose of this guide, general education is regarded as that part of knowledge, skills, and attitudes needed by each individual to be effective as a person, a member of a family, a worker, and a citizen.
Industrial Arts	Industrial arts is the study of industrial tools, materials, processes, products, and occupations pursued for general education purposes in shops, laboratories, and drafting rooms.
Industrial Arts Education	Industrial arts education is a synonymous term for industrial arts.
Industrial Education	Industrial education is a generic term used to designate various types of education of an industrial nature, vocational industrial education, industrial arts, technical education, and apprenticeship training in both public and private schools.
Comprehensive (Composite) General Shop	The comprehensive general shop may be defined as a type of organization which provides equipment and facilities for activities in two or more industrial areas. Actually, the number of areas represented may vary from two to as many as ten or more. For example, a comprehensive general shop might include experiences in woodworking, drawing, metalwork, and electricity. A more extensive development might include such additional areas as graphic arts, ceramics, textiles, leatherwork, and transportation. The limiting factors are the equipment and space available, and the interests and abilities of the teacher. This type of shop organization has been developed to meet the exploratory needs of pupils, especially in the one teacher situation. It has also been used extensively as a beginning experience to be followed by more intensive courses in limited general or unit shops. That the comprehensive general shop is meeting a real need and is growing in favor is indicated by the fact that more pupils are enrolled in this type of organization than in any other single industrial arts activity.[1]
Limited General (Major Area) Shop	The limited general shop has many of the features of the comprehensive type, but the activities and facilities are limited to work with a single basic material such as metal, wood, or to a closely related group or family of industries such as the electrical industries. An example is the general wood shop, which might include such activities as cabinet making, carpentry, woodfinishing, upholstery, wood carving, wood turning, model making, and pattern making. This type of organization is becoming increasingly common in larger cities where it is desired to give pupils the benefit of a truly exploratory experience, but where the duplication of many comprehensive general shops is impractical. Pupils are frequently rotated through several different limited general shops.[2]

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[1] A Guide to Improving Instruction in Industrial Arts, American Vocational Association, Washington, D. C., 1953. p. 30.

[2] Ibid, pp. 30-31.

Unit Shop	The unit shop is usually limited to activities in a single industrial occupation. Examples are machine shop practice, welding, cabinet making, letterpress printing, and sheet metal work. Such organization is now found largely at the senior high school level where it appears to be needed for extensive specialization, or in large city systems where by rotation through many different unit shops pupils may approach the exploratory outcomes of the comprehensive or limited general shop.[3]
Vocational Education	A program of education organized to prepare the learner for entrance into a particular chosen vocation or to upgrade employed workers; includes such divisions as trade and industrial education, technical education, agricultural education, distributive education, and home economics education.[4]

References:

1. *A Guide to Improving Instruction in Industrial Arts,* American Vocational Association, Washington, D. C., 1953
2. Good, Carter V. (ed.) *Dictionary of Education,* McGraw-Hill Book Company, Inc., New York, 1959

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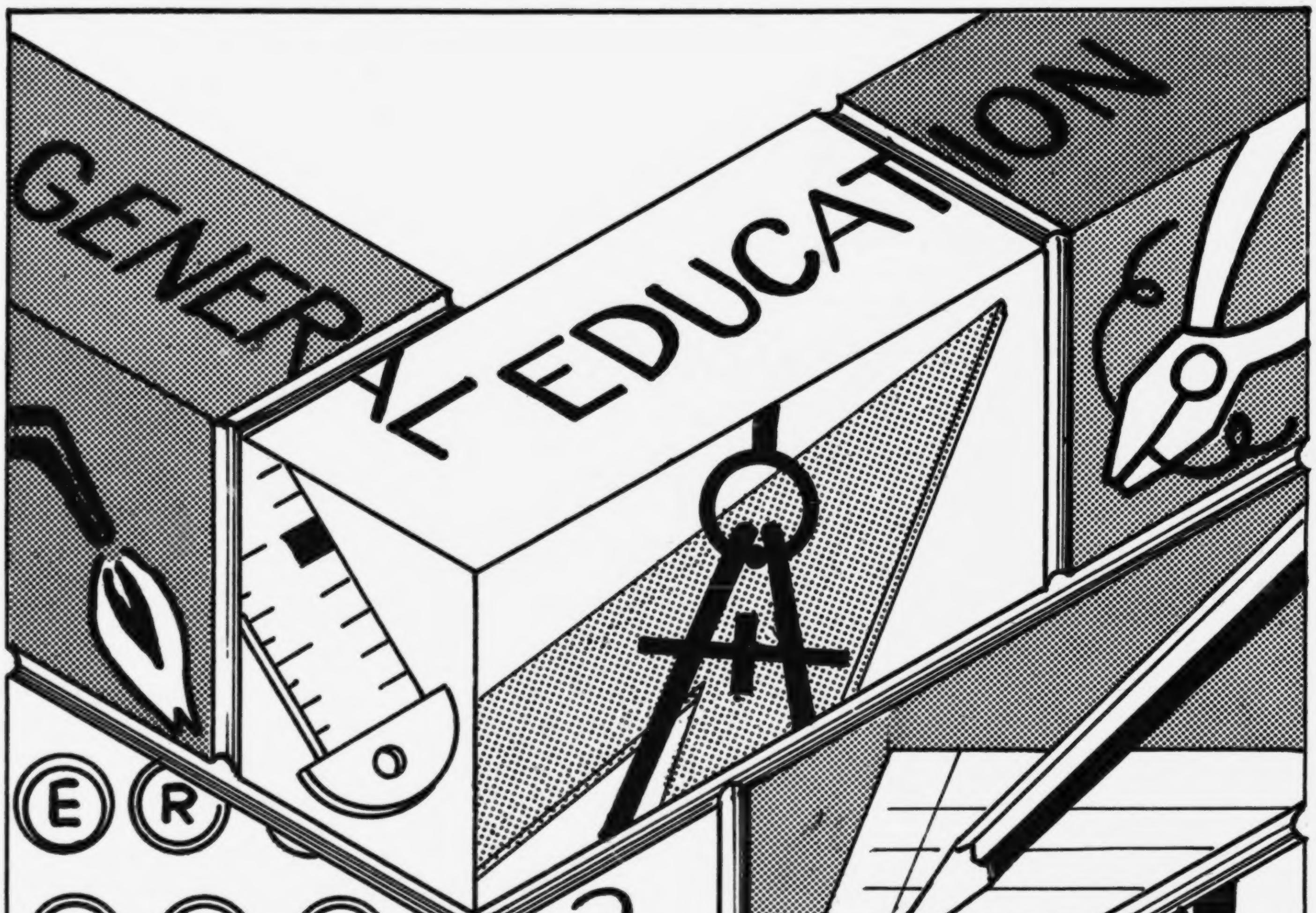
[3] Ibid, p. 32.

[4] Good, Carter V. (ed.), **Dictionary of Education,** McGraw-Hill Book Company, Inc., New York, 1959. p. 603.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CHAPTER II

THE PLACE OF INDUSTRIAL ARTS IN THE GENERAL EDUCATION PROGRAM

The Relation of Industrial Arts to General Education

Industrial arts education is a subject area defined as dealing with the understanding and interpretation of industrial activity. As an important part of general education, industrial arts education is concerned with materials, processes and products of industry. The student not only seeks knowledge of the industrial society in which he lives, but also learns how to use tools, work with materials, and perform basic processes. He defines problems, postulates solutions by design and written description, develops solutions, and tests products or manufacturing principles for validity.

Industrial arts education is not taught as a separate subject only to master a skill, but it is concerned with those phases of the subject which are related to life in general and the fulfillment of the purposes of general education.

The pictorial illustration on page 6 portrays the contributions of the field of industrial arts education to the general education of the individual pupil. Sketching and design become an essential medium for thinking and communication, and at the proper level of specialization is taught as an important separate area. The actual project developed experimentally tests the idea, therefore, developing skills, science, planning, creative expression, appreciation of materials and industry, and other phases of education necessary for balanced adjustment of the student.

Changes in industrial techniques also mean changes in other aspects of our economic life. New occupational structures resulting from new industries, inventions, or materials often mean changes in job opportunities, required skills, hours of work, financial return, leisure pursuits, retirement, and other related services. Methods of investing, methods of selling, distribution of goods, handling management-labor relations, and a myraid of other related aspects are influenced by new innovations. Industrial arts education can and does have a proud part in helping youngsters solve their problems resulting from such changes by aiding them to perceive these changes and to plan accordingly. Opportunities for correlation with mathematics, social studies, science, business, and the language arts are very extensive, and should be emphasized and used fully.

Children, adolescents, and adults of both sexes can find rewarding and satisfying experiences in manipulative and investigative activities of a technical nature. The need for activity is paramount at all levels of maturation and growth.

Children of the elementary school level are constantly developing motor skills in all experiences to which they are exposed. Adolescents of the early secondary levels are learning to extend and refine their abilities in activities of close manipulative nature. Success helps youngsters develop confidence and provides a basis for further motivation. The varied opportunities in industrial arts education offer a measure of success for everyone. Other personal-social needs can also be satisfied in a laboratory setting.

The general nature of the industrial arts education program provides opportunities for varied abilities and interests. The work can be challenging to the exceptional pupil and also to the youth of lower intellectual ability. Interest in technical work can raise the need for greater skill in the fundamentals.

Students often find it necessary to increase communicative skills to solve problems in the laboratory through reading and investigation. Problem situations in industrial arts accompany knowledges and communicative skills studied in the classroom. Thus, the high level of integration and correlation which can be achieved through coordinated effort is made clear to students and teachers.

As the pupil begins and advances with his industrial arts education training in the laboratory, he encounters specific training both directly and indirectly that is deemed necessary for achievement of the objectives of general education as interpreted by currently formulated objectives of industrial arts education.

As the pupil progresses further, he or she proceeds to assemble and retain within individual capacities and abilities, his education and training. Industry, teacher, school and community exert definite influences upon course content and policies regarding instructional methods and desired outcomes. There is a recognized individual contribution with respect to these authorities; however, considerable attention and effort are devoted to their close correlation in order to achieve a balanced overall educational plan.

After sufficient knowledge and manipulative training has been effected, the individual usually follows one or more separate pursuits in the application of his acquired industrial arts education learning as associated with education for living. A student may develop and expand his training with the eventual goal being a specific vocation; he or she may choose to follow an avocational approach, utilizing his development for worthwhile use of leisure time in personal recreation and hobby development; or, he or she may consciously or unconsciously use many of the acquired citizenship values and concomitant-learnings.

The Industrial Arts Program — Its Aims and Objectives

The development of industrial arts education to its present stage was simple and logical. Since wood was used widely in home and industry, was relatively inexpensive, easy to work, and necessitated only common hand tools, it became one of the early key materials for teaching industrial arts. Since paper and common drawing instruments also qualified for the same reasons, mechanical drawing also became a basic subject.

With increasing availability and use of metal, development of the automobile for transportation, growth of the graphic arts industry for the dissemination of knowledge, electricity for power and communication, a gradual introduction of these activities began in industrial arts education. In more recent years, new materials and processes, such as plastics, modern metal alloys, the semi-conductors, photo-offset lithography, photography, and light portable tools challenge the teacher and the planner of industrial arts education facilities.

The present emphasis in industrial arts education is toward the following basic industries:

1. Crafts
    a. Ceramics
    b. Jewelry
    c. Leather
    d. Plastics
    e. Textiles
2. Electricity and electronics
3. Graphic arts
4. Mechanical drafting
5. Metals
6. Power and transportation
7. Wood

The laboratory setting should be organized for close correlation with and enrichment of such social studies areas of industry as the following:

1. General organization
2. Names and location of current plants in major industries
3. Distribution and sales of products
4. Typcial processes and operations
5. Labor-management relations
6. General financial structure and stock market securities
7. Securing of raw or semi-manufactured materials
8. Product analysis
9. Subsidiary contracts
10. Types of industrial research
11. Patent procedures, and the like

In order to teach and learn of the current industries it is necessary to have resources such as maps, charts, graphs, films, models, mock-ups, raw materials, and products. The laboratory setting should be conducive to work beyond the purely manipulative aspects of industry.

As we set out to develop a curriculum certain basic assumptions are made to serve as a basic philosophy for the evolving program in industrial arts education.

FIRST, we recognize certain important basic facts regarding our society:

1. That ours is a highly mechanized society.
2. That all occupations are becoming more and more dependent upon machines and automation.
3. That practically everything we use is a product of industry and mass production.
4. That industry is subject to rapid change—constantly producing new products with new materials and consequent new procedures.
5. That of necessity, workers from the unskilled to the professional designers are relearning their jobs

every five to seven years.

6. That at best we can predict only the general fields of industry and aptitude of our school youth in selecting a vocation.
7. That, even then, the force of chance and circumstance further complicates vocational predictions.

SECOND, within the formative years, in addition to the well recognized moral values and basic skills, we must develop in our students the following:

1. **Versatility**—the inner capacity to adjust when change implies the necessity.
2. **Understanding**—the desire to seek the basic and fundamental "why" in all instruction.
3. **Work attitudes**—the value of responsibility, honesty, loyalty, cooperativeness, patience, persistence, initiative, and confidence in maintaining our democratic way of life.
4. **Job background**—job vocabulary, job classifications, purpose behind the various skills, traditions, and romance of the various occupations.
5. **Tool knowledge**—enough language, sciences, mathematics, arts, manipulative skills, and business techniques to achieve full personal stature.
6. **Learning habits**—a realization that learning and re-learning will go on continuously and that a few mental gymnastics mastered early will be of tremendous value throughout their productive years.

THIRD, we recognize that industrial arts education, which is concerned with industry and its organization, materials, tools, processes, occupations, products, and problems, is a significant part of the life preparation of all youth. Through selective and integrated activities, we can serve students destined for all occupational areas — the sciences, business, arts, industry, homemaking, and the professions in their effort to do the following things:

1. Work effectively with others as a leader or as a member of the group.
2. Read and understand drawings, graphs, and charts.
3. Convert ideas to plans and workable procedures to construct or understand the construction of the typical products of industry.
4. Understand American industry, including such phases as organization, location, raw materials, products, labor-management relations and distribution and sales.
5. Understand and give expression to the mechanical aspects of all subject matter and daily experiences.
6. Apply the principles of science and mathematics to the basic processes of industry.
7. Acquire basic skills used by industry.
8. Recognize quality and design in their own products and those of industry.
9. Maintain and use these products in a safe and efficient manner.
10. Explore the typical occupational areas of industry and lay a foundation for, and advance in, a chosen area.
11. Develop an interest in the crafts as a medium for creative expression in leisure time.

FOURTH, it is recognized that the curriculum in industrial arts be sufficiently flexible and appropriate in content and approach that it can serve the needs of all groups of students, namely:

1. The mechanical-minded student who needs a strong background in industrial arts for business enterprises in the fields related to mechanics, apprenticeship in the mechanical trades, or added technical courses after high school to prepare for vocations in the manufacturing, construction, transportation, graphic arts, communications, or power industries.
2. The college-preparatory student who needs at least the basics in drawing, electricity, and tool and machine processes as a practical foundation for engineering and the other scientific professions.
3. Students with only a casual mechanical interest in how things are made and how they work. Mostly a craft interest in mechanics as applied to hobby and general maintenance activities at the consummer level.

Grade Placement of Industrial Arts in Education Programs

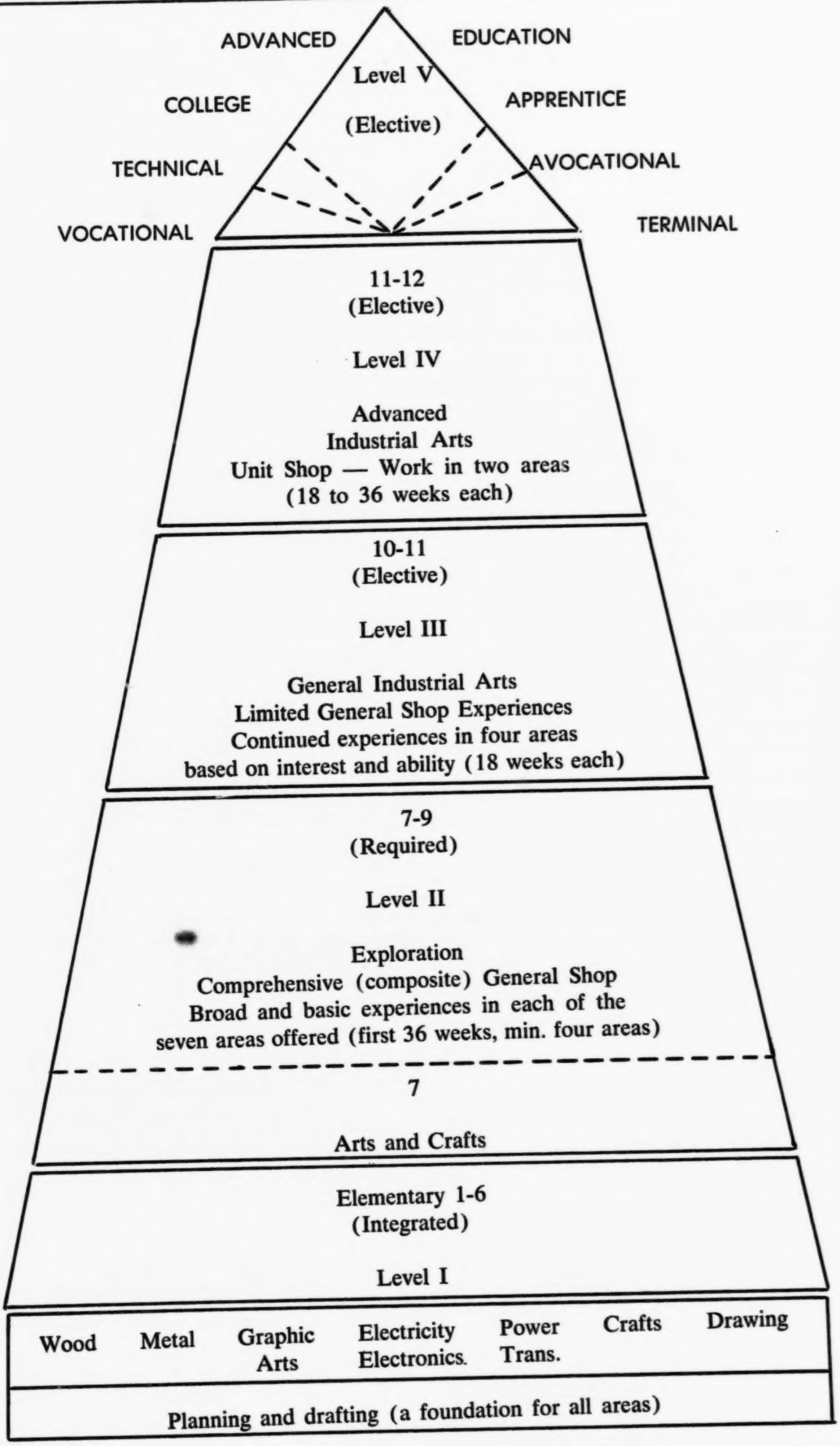
This study guide is primarily intended for the industrial arts instructors in the junior and senior high schools of Colorado. However, it should be recognized that some phases of industrial arts are desirable at all levels of instruction.

It is believed that industrial arts has unlimited opportunities for teaching appreciation of environment and raw materials of industry. Therefore, activities within this area are appropriate and of high educational value whether taught as a separate subject area, or correlated closely with other subject areas, or integrated completely with the total program to the extent that they are not identified.

To accomplish the aims and purposes of industrial arts education, the program should be organized on five levels (see chart on the following page).

Level I — Kindergarten and Grades 1 through 3

In the lower elementary grades (K through 3) the emphasis in the learning activities and the interest of the students is centered around their immediate environment which consists of the home, the school, and the neighborhood. Many aspects of this environment are closely related to industrial arts and are familiar to the students. It is possible to relate new items of knowledge to those areas in which children have a natural interest and about which they desire to learn more.


ADVANCED
EDUCATION
Level V
(Elective)
COLLEGE
APPRENTICE
TECHNICAL
AVOCATIONAL
VOCATIONAL
TERMINAL
11-12
(Elective)
Level IV
Advanced
Industrial Arts
Unit Shop — Work in two areas
(18 to 36 weeks each)
10-11
(Elective)
Level III
General Industrial Arts
Limited General Shop Experiences
Continued experiences in four areas
based on interest and ability (18 weeks each)
7-9
(Required)
Level II
Exploration
Comprehensive (composite) General Shop
Broad and basic experiences in each of the
seven areas offered (first 36 weeks, min. four areas)
7
Arts and Crafts
Elementary 1-6
(Integrated)
Level I
Wood
Metal
Graphic Arts
Electricity Electronics.
Power Trans.
Crafts
Drawing
Planning and drafting (a foundation for all areas)

LEVELS OF TEACHING IN INDUSTRIAL ARTS

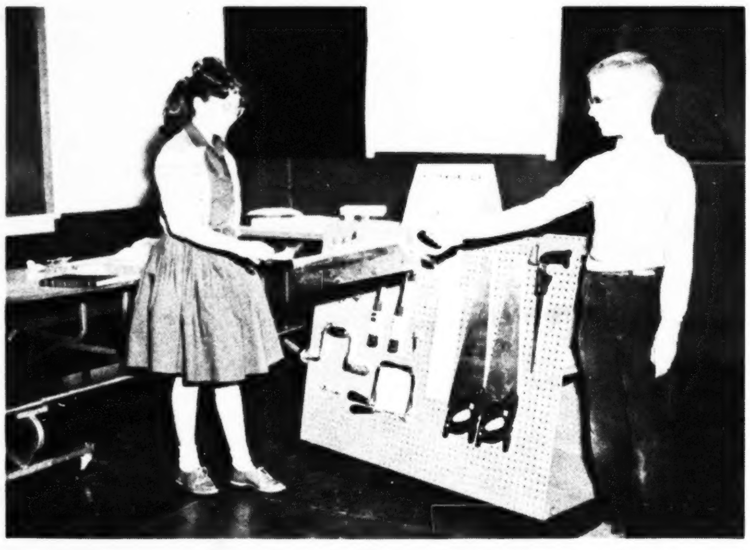
Industrial arts *is not* to be taught as a separate subject but it should be integrated with other fundamental subjects and the industrial arts experiences should be utilized to deepen, enrich, and extend the learnings of the other areas of work. Industrial arts in this sense would become a way or method of teaching. Activities are stimulating enrichment for other areas.

As the child matures and progresses in school, the neighborhood for him will include the community with some of its functions, and activities, in which he and his family are concerned and participate. Holiday activities, seasons of the year, and activities in the neighborhood draw repeatedly upon construction, utilizing readily available and easily worked materials.

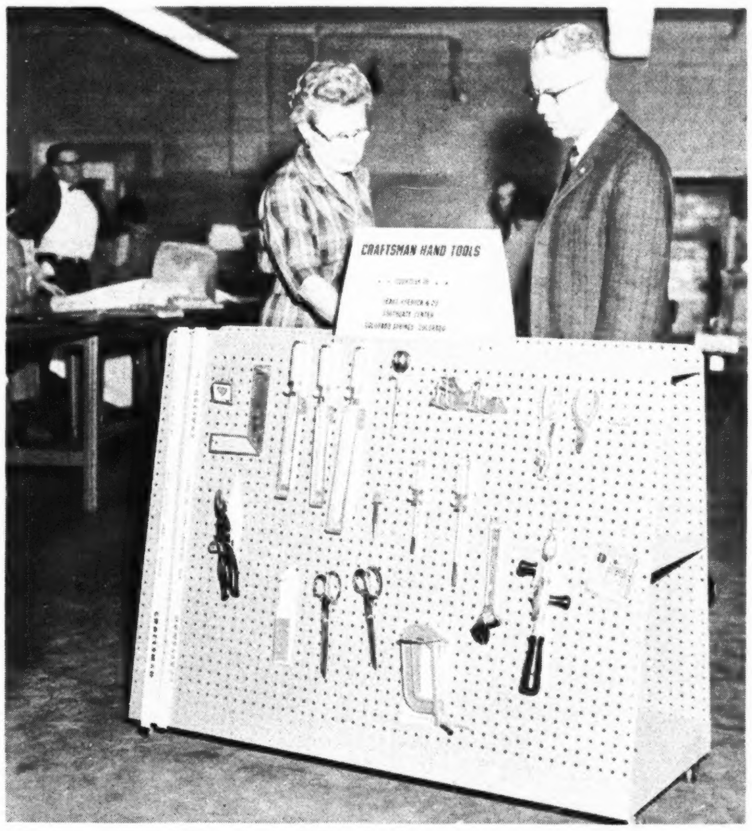
These interests will lead to a wider knowledge of the community activities. The students will be interested in the activities of the city, the farm, airports, space ships, space travel, firemen, policemen, trains, trucks, houses, foods, clothing, and many activities in which industrial arts can easily vitalize the program.

Their interest will then broaden much more and the topics for study and discussion will be centered around how food, shelter and clothing are obtained; how we travel and communicate with each other; our sources of water, electricity, fuel, and other necessary services; the characteristics of a good community; responsibilities of good citizens; and will also include a comparison of how people in different communities and countries live.

The teacher should provide an opportunity for creative activity in acquainting the child in the use of paper, wood, textiles, clay and many other simple materials to show how they are involved in the problems of food, clothing and shelter. Teachers should find the self contained classroom the most satisfactory setting to yield an acceptable degree of correlation of the learning activities. Tools and materials appropriate to the work are brought into the classroom.



In situations where a therapeutic need is to be met, more permanent and extensive facilities are required. In these cases, work areas and storage for tools and materials should be designed as a permanent area of the self-contained classroom.



Level I — **Upper Elementary Grades 4 through 6**

In grades 4-6 the industrial arts activities are of a more realistic nature utilizing individual and group undertakings to enrich the science, and social studies activities. At this level industrial arts may be integrated to any degree desirable or it may be identified, but taught in close correlation with other subjects. Emphasis should be placed on the broad areas of transportation, manufacturing and construction. The industrial arts activities will also serve to enrich and interpret the content of other subjects.

Most of the activities may be planned and directed in the self-contained classroom under the direction of the classroom teacher. Some, however, may require additional space and equipment, and a special activity room is desirable. This room needs only simple equipment (hand tools) and can serve several groups. The services of a special teacher in this area are desirable to assist the regular classroom teacher with some of the specialized activities. These services can best be utilized with a portable tool panel and work bench that may be easily moved from room to room as needed.

The preparation of the elementary classroom teacher becomes the key to the program's success. Through lack of experience, many teachers hesitate to incorporate such work into their programs. Actually, industrial arts techniques at this level are natural and easy. Pre-service courses, in-service extension courses, and assistance from secondary school industrial arts teachers are available to elementary teachers who need assistance.

Level II – **Exploratory Industrial Arts Education, Grades 7-9**

Since the exploratory courses are a part of the general education program, they should not be elective. There is a strong feeling among authorities in the industrial arts field that a program of exploratory arts and crafts should be required of all youth, both boys and girls, in grade seven. It is hoped that these experiences will include some work in drawing, sketching, planning, leather, textiles, art metal, and wood carving.

It is also desirable that exploratory courses in grades eight and nine should be required of all boys as well as an elective course for girls. The keynote of the program is exploration of the likes and dislikes, discovery of aptitudes, an investigation of tools, materials, and basic processes of our contemporary industrial society. The courses provide help with educational, avocational, and vocational guidance of the student.

The work should be an activity program with related information to provide an understanding of the processes of American industry. The information units at this level should be general in character and devoid of too much detail. Also, the research and experimentation approach to teaching in the industrial arts laboratory opens new avenues of learning.

The experiences should be as broad as possible with introductory work taken in all areas. These should include: planning and drawing, wood, metal, electricity, graphic arts, crafts, and power transmission.

This area of instruction lends itself to the comprehensive (composite) general shop which is closely related to the function of the junior high school. Throughout the history of the junior high school movement, major emphasis has been on exploration and guidance, and provision for individual differences. The activities general shop fulfills these concepts by stressing exploratory activities in a diversified program. The general shop enriches the junior high school curriculum with its varied program and assists the student in a smooth transition between the elementary grades and the high school.

It is suggested that the comprehensive general shop in this guide be a four area shop. The thirty-six weeks of instruction in the eighth grade should include drawing and planning, wood, metal, and the fourth unit chosen by the instructor to fit the physical plant and the needs and interests of the pupils. The suggested units of instruction as shown in this guide were intended to meet the needs of all areas of instruction. **The junior high teacher should choose the processes applicable for the areas offered in the school shop.**

The ninth grade students should choose from the areas of drawing, electronics, graphic arts, power mechanics, crafts, etc., and perhaps limited general shop experiences in other areas.

Level III – **Orientation (limited general shop) Grades 10 and 11**

The work taken in grades ten and eleven should be elective courses. The function here is to continue the exploration but at the same time give greater depth to the subject. Basic learnings give way to individual initiative in selection of problems. The plan of the program aims at fulfilling the objectives through individual work, group projects, planned visitations, visual aids, related lessons, and other means at the disposal of the teacher.

The scope of the work at this level should continue on a broad base for those majoring in industrial arts education type work with experiences in a minimum of four areas of the seven that are shown in the pictorial illustration (page 11). For the student in the college preparatory curriculum with engineering or a similar scientific goal, courses in drafting, metals, wood, power and electricity-electronics would be most helpful. To the other college preparatory students, and those in general curriculum, the courses should stress leisure time activities and a general knowledge program.

Level IV – **Advanced Industrial Arts Education**

Grades 11 and 12

Work at this level should be elective. The classes on this level should provide considerable depth for those following an industrial arts education curriculum. The work should be concerned with an understanding of the "why behind the how." It is difficult to teach a specific skill for vocational purpose because of the rapidly changing employment picture. On this level skills within an occupational family should be developed so the student can adjust to the technological changes.

The work on this level should be for the full year in two areas for those majoring in industrial arts education. This type of instruction should be carried on in a unit shop with a pre-vocational emphasis.

For the college preparatory and general curriculum students, additional courses on level III could be selected.

Special Courses—Special courses can be organized within the existing framework of the industrial arts facilities. Courses such as this serve both boys and girls on any level for the general handyman activities required in today's home.

Adult Level – Post High School

Shop and industrial laboratory programs for adults will vary with the interests and needs of the local community. They may be concerned with consumer, hobby and other forms of avocational interests. In abnormal times they may also meet limited vocational needs through special courses for retraining to relieve technical unemployment, on-the-job advancement or the special needs of a community during a major crisis.

College Level –

Industrial arts education on the college level is two parts: (1) college or university leading to a baccalaureate degree, and (2) junior college, generally thought of as terminal, and leading to an associate of arts degree. In the senior college and university level industrial arts education has three purposes: (1) professional teacher training, (2) general industrial arts education, and (3) recreational-avocational.

The professional teacher training program consists of the concentrated major of industrial arts education, a basic college course of general education plus professional courses in education. The courses in industrial arts education may be elective for any purpose the student may wish to use them.

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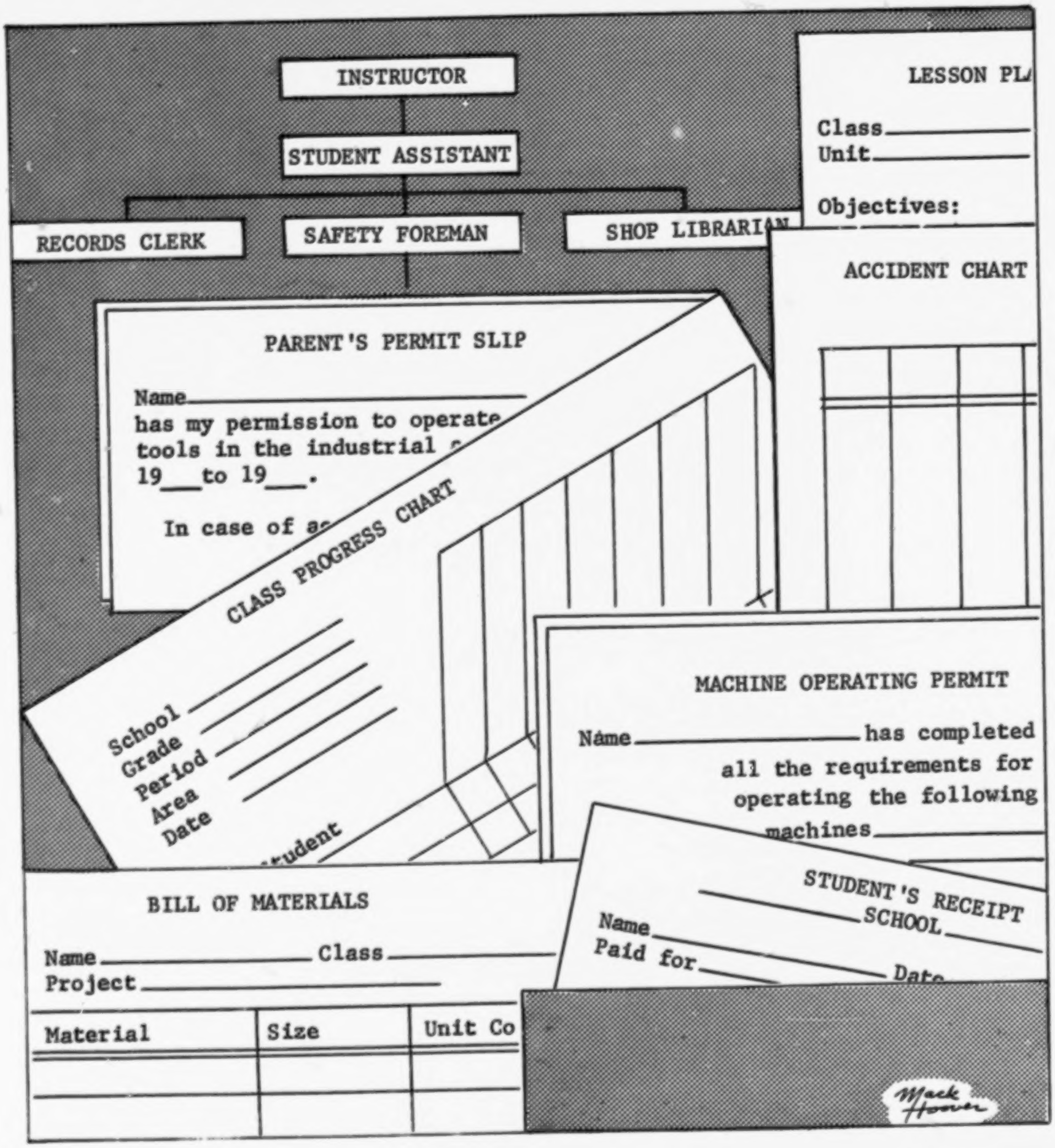
ORGANIZATION & ADMINISTRATION


INSTRUCTOR
STUDENT ASSISTANT
RECORDS CLERK
SAFETY FOREMAN
SHOP LIBRARIAN
LESSON PL
Class
Unit
Objectives:
ACCIDENT CHART
PARENT'S PERMIT SLIP
Name
has my permission to operate
tools in the industrial
19__ to 19__.
In case of a
CLASS PROGRESS CHART
School
Grade
Period
Area
Date
Student
MACHINE OPERATING PERMIT
Name has completed
all the requirements for
operating the following
machines
STUDENT'S RECEIPT
SCHOOL
Name
Paid for
Date
BILL OF MATERIALS
Name
Class
Project
Material
Size
Unit Co
Mack Hoover

CHAPTER III

ORGANIZATION AND ADMINISTRATION IN THE INDUSTRIAL ARTS CLASSROOM

Planning the Program

Careful planning before the start of the school year will determine the success of the industrial arts program. Everyone is aware of the detailed planning that takes place in industry. Dealing with groups of lively youngsters working in varied activities makes it imperative that each day be planned within the objectives set for the course.

It is often felt that planning courses of study and daily lesson plans is almost impossible with students working on different projects in different areas. This is often an excuse to omit planning entirely. Shop classes require detailed planning to operate successfully. If it can be taught it can be planned!

Consider the following when planning the program:

1. Objectives based on the needs of the students in their particular community.
2. Courses of study aimed at these objectives.
3. Lesson plans: flexibility necessary.
4. Importance of related information:
    a. Enriching the offerings of the course and helping to fulfill the general education values of industrial arts.
    b. Providing information about job opportunities and the world of work.
5. Knowledge, importance of attitudes and skills.
6. Teaching aids:
    a. Shop library
    b. Films
    c. Neat, attractive bulletin boards
    d. Displays and exhibits
    e. Instruction sheets
    f. Field trips
    g. Models and miniatures
    h. Pupil-personnel charts
    i. Progress charts
    j. Safety posters

Beginning the School Year

The first contact made with students is extremely important. Vivid impressions are made and the tone is set for the remainder of the school year. Every teacher is different and will follow many of his own ideas in starting the class. There is no set, exact way of doing things and this is as it should be. The teacher may find the following suggestions helpful:

First Day Suggestions:

1. Present yourself neatly with a well pressed shop coat or apron. This leaves a good impression. Wear a name plate.
2. Write the name of the course and your name on the chalkboard.
3. Seat students as soon as they enter the shop.
4. Get acquainted with your students:
    a. Introduce yourself and give them a brief description of your background.
    b. Have each student introduce himself and tell of his hobbies and interests.
5. Pass out enrollment cards or a sheet on which students will write their names. Stress clarity in writing!
6. Discuss safety and tie it in with:
    a. Good housekeeping
    b. Orderly performance
    c. Proper behavior

7. Give a brief overview of the course. (Costs, grades, etc.)
8. Show models of various projects (slides and pictures)
9. Tour the shop if time permits.

Suggestions Which May Be Covered During Remainder of the Week:

1. Assign work stations.
2. Explain work to be covered in various areas if in general shop.
3. Explain rotation in a general shop.
4. Discuss purpose and values of shop courses, tie them in with entire school program. Explain how they fit into the school's philosophy of education.
5. Discuss terms such as general shop, industrial arts, vocational education.
6. Discuss aptitude. Explain that students have a wide range of abilities just as in sports. Use examples.
7. Explain about aprons and proper dress for safety.
8. Lay foundation for proper shop conduct:
    a. Discuss proper attitude towards work and fellow students.
    b. Discuss personal safety. (Check with school on insurance)
    c. Discuss regard for school equipment and materials.
9. Explain the progress chart and grading system.
10. Explain paying for materials, shop fees.
11. Explain policy regarding make-up work.
12. Explain or discuss and construct student-personnel organization.
13. Explain school policies: absences, tardy permits, passes from class, fire drills, assemblies, lunch periods, and school bells.

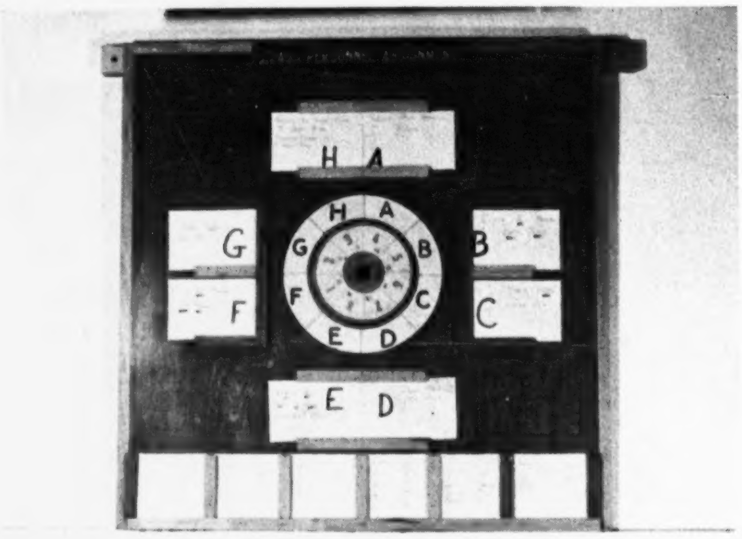
Personnel Organization in the Classroom

The class should be organized in such a way as to make each member feel he is a responsible member of a team. The instructor might present his own plan to the class for acceptance or suggestions, or the group may construct the plan under the leadership of the instructor. Two suggested personnel organization plans are illustrated on pages 19 and 20.

A good pupil personnel organization is one of the keys to efficient operation of shop classes. Its main function is to improve instruction by relieving the instructor of many routine jobs characteristic of the shop.

Each instructor should set up a plan that will best fit his own situation depending on the type of class, number of areas taught, size of class and grade level. In order to be successful it should always be remembered that the teacher is in complete charge of all instruction. This responsibility should not be delegated to the students. The organizational plan should be presented in such manner that the students are willing to accept the plan. Operated properly it should also promote good citizenship through training in leadership, followership, cooperation, and in accepting responsibility. It should also provide for a better understanding of industry in utilizing its line type organization.

Mechanical aids commonly used for assigning students to duties are the rotating wheel, wood block set-up, and lists.



Rotating Wheel: Students' names, work assignments and time intervals are placed on different sized discs and rotated at various intervals.

The Wood Block Method: Students' names are fastened on ¼″ thick rectangular pieces of wood which slide in a channel opposite the different jobs. For rotation, the bottom name is removed and placed on top.

Lists: Sheets are typed which include the names of the students with their assignments.

Duties of the shop superintendent:

This is the most important student position in the school shop. The superintendent should be elected by the class. He should set an example for good student behavior in developing citizenship. He should:

1. Arrive in the shop as soon as possible after the bell rings, obtain the keys from the in-

structor and open the storage lockers for his class.

2. Assist the instructor in starting and dismissing the class.
3. Keep a list of the various unit foremen and coordinate their work.
4. Help his foremen whenever necessary.
5. Help his foremen in selecting substitutes for absentees.
6. Maintain an alert for violations of safe practices.
7. Help the instructor in clean-up inspection.
8. Report irregularities to the instructor.
9. Assist new students in their duties.
10. Lock all cabinets at the end of clean-up and return keys to the instructor.

Duties of unit forman should be:

1. Keep a list of all boys in his unit.
2. Maintain an alert for violations of safe practices.
3. Have charge of the tool panel in his area and check to see that all tools are returned.
4. Check to see that all benches and machines are swept clean in his area.
5. Check to see that all supplies are returned to their proper place.
6. Report missing tools or irregularities to the instructor.
7. Set a good example of student behavior.

Duties of unit foremen should be:

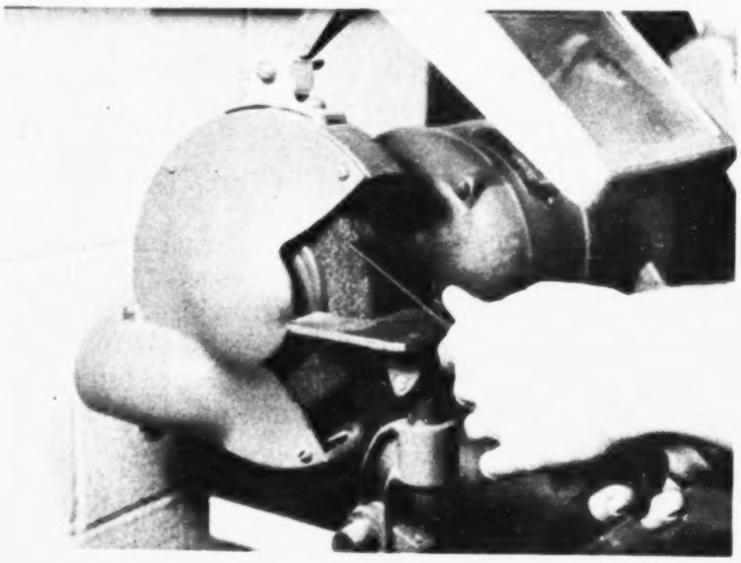
1. Assist the instructor in his responsibility for the safety of all students.
2. Watch carefully for violations of safe practices.
3. Report all violations of safe practices to the instructor.
4. Watch students for loose clothing that might be a hazard when working with machinery.
5. Check for students talking to a machine operator.
6. Check on "bunching up" by students around machines.
7. Help students arrange projects neatly in storage cabinets.
8. Check on the care of all machines. See that all guards are in working order, and goggles or plastic face masks are at all machines.
9. Assist the instructor in giving safety tests prior to the student using a machine.
10. Check the first aid kit and keep material in neat order.
11. Assist the instructor in maintaining a safety bulletin board.
12. Check tools for loose handles, broken parts, etc.
13. Report injuries.
14. Light gas furnaces.

Duties of secretary should be:

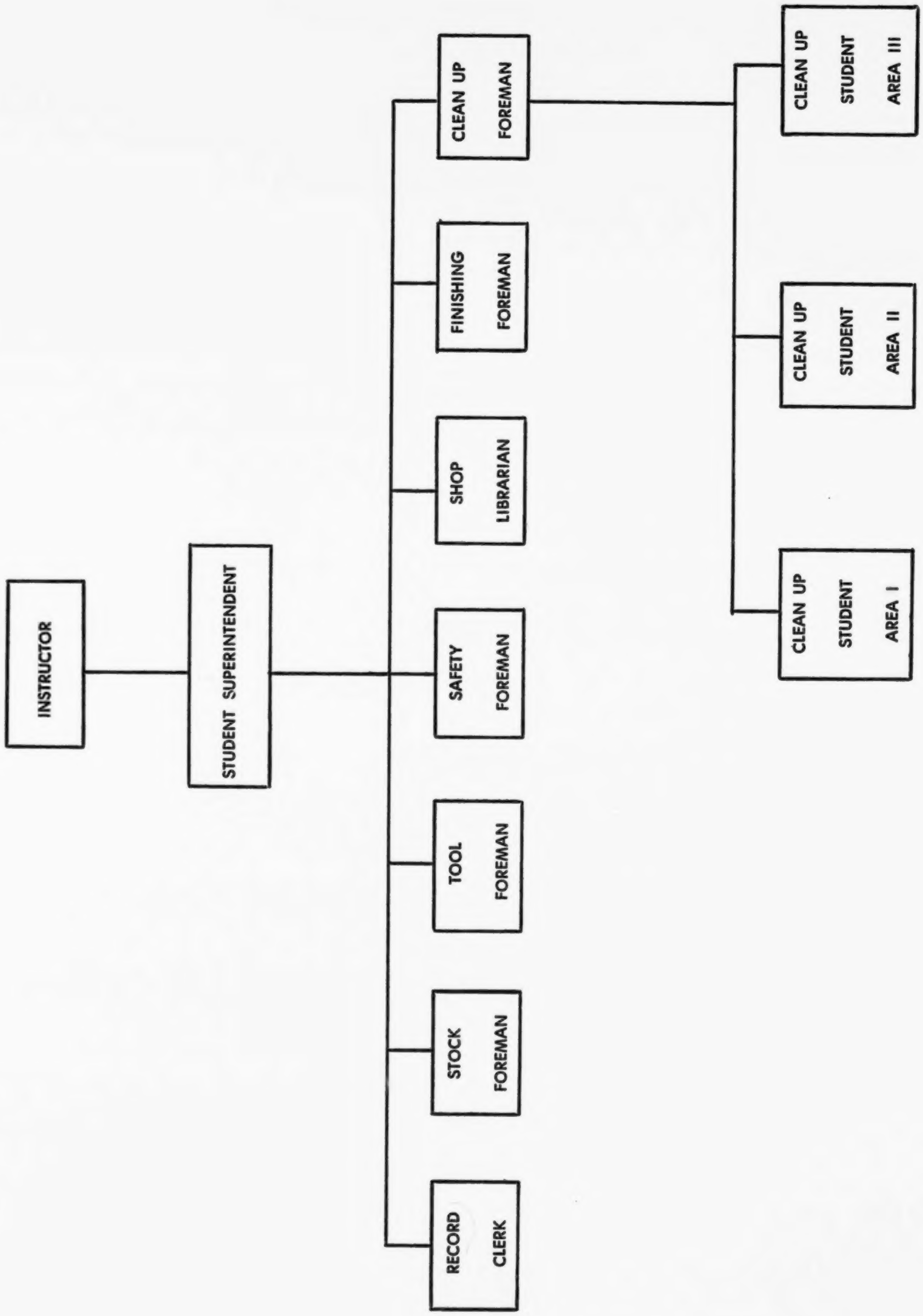
1. Assist the instructor in checking attendance.
2. Assist in keeping student record cards.
3. Act as timekeeper.
4. Check the order of the planning area in keeping books and magazines in proper places.
5. Take over superintendent's duties in his absence.

Duties of tool foreman should be:

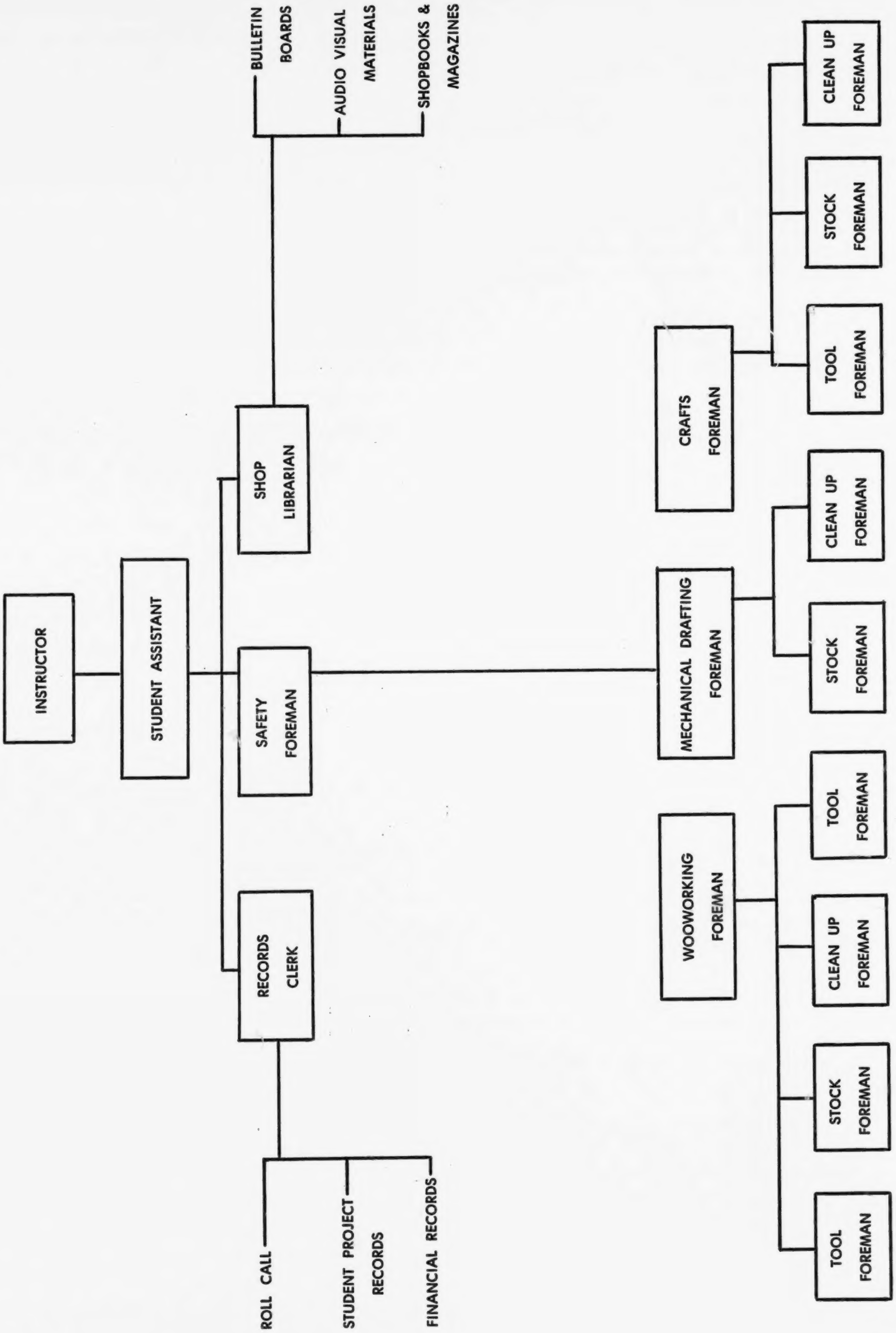
1. Have charge of all tools in the shop in either a tool room or on panels.
2. Check out and take in all tools if shop has a tool room.
3. Keep all tools neat and orderly.
4. Report all damaged or missing tools to the instructor.
5. Recondition some of the tools.



PERSONNEL ORGANIZATION CHART


INSTRUCTOR
STUDENT SUPERINTENDENT
RECORD CLERK
STOCK FOREMAN
TOOL FOREMAN
SAFETY FOREMAN
SHOP LIBRARIAN
FINISHING FOREMAN
CLEAN UP FOREMAN
CLEAN UP STUDENT AREA I
CLEAN UP STUDENT AREA II
CLEAN UP STUDENT AREA III

PERSONNEL ORGANIZATION CHART


INSTRUCTOR
STUDENT ASSISTANT
RECORDS CLERK
SAFETY FOREMAN
SHOP LIBRARIAN
ROLL CALL
STUDENT PROJECT RECORDS
FINANCIAL RECORDS
BULLETIN BOARDS
AUDIO VISUAL MATERIALS
SHOPBOOKS & MAGAZINES
WOOWORKING FOREMAN
MECHANICAL DRAFTING FOREMAN
CRAFTS FOREMAN
TOOL FOREMAN
STOCK FOREMAN
CLEAN UP FOREMAN
TOOL FOREMAN
STOCK FOREMAN
CLEAN UP FOREMAN
TOOL FOREMAN
STOCK FOREMAN
CLEAN UP FOREMAN

Records — Shop Accounting and Inventory

Record-keeping is a vital aspect of the well-organized and administered industrial arts program. Even though this phase of the work may seem tedious, pride should be taken in the efficient handling of records which utimately provide for improved instruction.

Whenever money or objects of value are handled, accurate, up-to-date records should be carefully maintained as a protection for both the teacher and the student. Records are a clear index of progress made by students, of material covered, lectures, demonstrations, and tests administered by the teacher.

Accurate background data concerning each student provides valuable information for better understanding of individual pupil needs, and individualization of instruction is one of the basic and prime functions of the entire junior high school program.

Material should be filed where it is easily accessible, probably in a metal file cabinet kept right in the shop. Many different forms and records are used. The instructor should select those which he feels are necessary to adequately cover his needs.

Among the forms most commonly used are:

1. Class-record book

   Provided by the administration to all teachers for recording name and number of course, year, period class meets, names of student, attendance, test grades, final grades, etc. Usually turned in at end of year.

2. Plan of procedure

   Made out by the student and checked by the instructor. Includes a record of the projects completed, supplies and tools used, estimate and actual time required to complete project, steps followed, references, sketches, and final grade.

3. Progress charts

   Includes names of all students with grades on projects completed. Also lists grades for tests, quarters and finals. May include information on work station numbers, work assignments or property issued. This sheet is posted where all may see it. A suggested form is illustrated on page 22.

4. Personal cumulative shop record sheet

   Usually maintained by the office. Includes a running account of all achievements of the student. Record of all shop courses taken, interests, hobbies, mental ability, physical record, outside work experiences, grades in all courses, and comments by teachers.

5. Lesson plans

   Used in teacher preparation of lessons. May be planned in advance for an entire course and revised as necessary. Required in some school systems and encouraged in most. Helpful, too, for substitute teachers.

6. Inventory forms

   For keeping an accurate record of supplies and equipment on hand. Should be checked by the new teacher and kept up-to-date. Include the following: name, number, make, catalog number and description of article; unit and total cost when new, date of purchase, source of purchase, serial numbers, condition, quality and condition of expendable equipment and supplies.

7. Material record card

   Individual record including name of student, period, name of course, year, projects, materials used, cost, amount paid and balance due.

8. Demonstration record

   A brief record of the demonstrations presented to the various classes, with dates.

9. Machine permit

   Written permit signed by parent allowing student to use power equipment upon completion of instruction by the teacher, and having passed a written safety test for the particular machine with a mark and score of 100 per cent accuracy. The test and the permit, signed by the parent allowing the student to use the power equipment, should be kept on file as long as the student remains in the class. (See illustrations of permit forms on page 23.

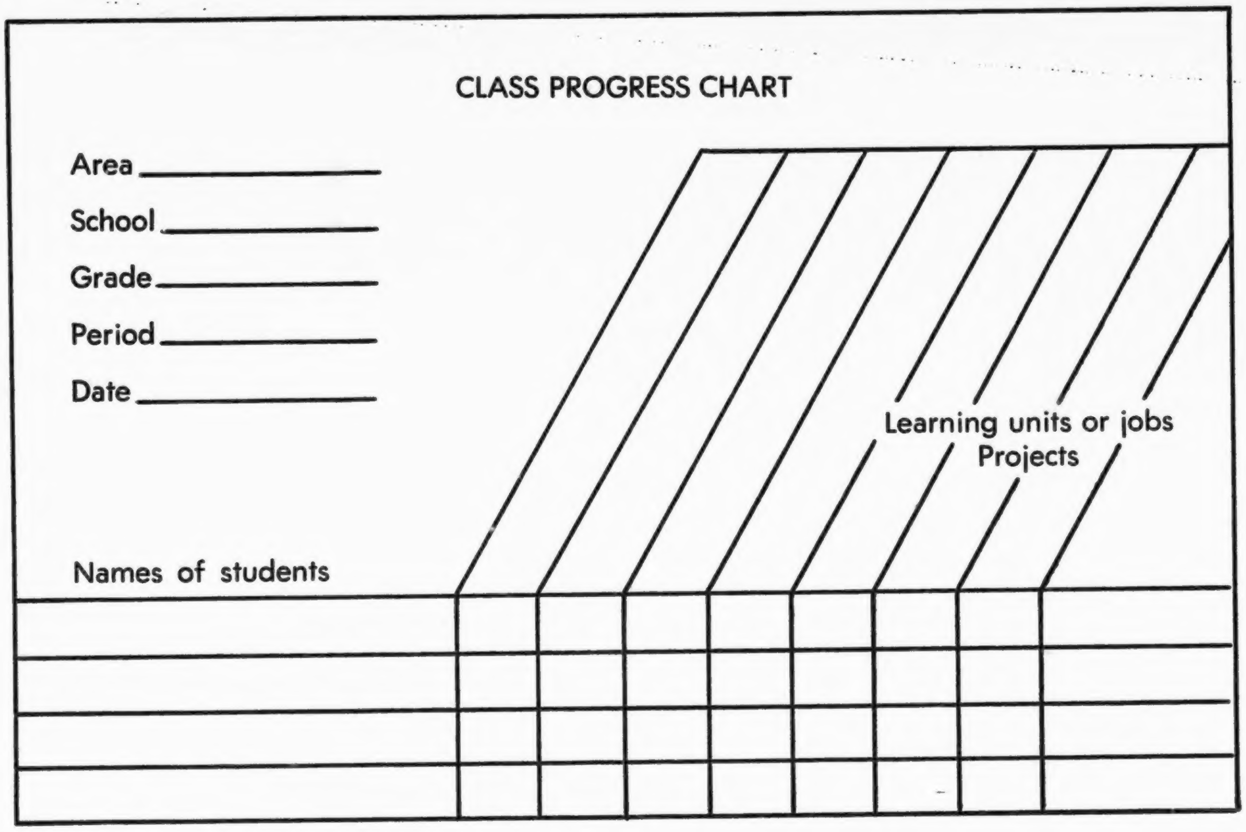
10. Requisition forms

    One of the non-teaching jobs with which every shop teacher is concerned is the requisitioning of supplies. This chore can be made more pleasant if an organized method of planning and ordering is followed. A wide assortment of expendable supplies is used during the course of each year. To insure a new supply of exactly the correct items, detailed specifications should be listed: description of material, size, unit of measure, item number, cost, date required, and manufacturer's name.

Individual Responsibilities in Collection of Money

It is recommended that money be collected in the main office of the school with the student bringing the receipt to the shop instructor for shop records. A sample receipt is shown on page 22.

PROGRESS CHART (Form)



CLASS PROGRESS CHART

Area ______________

School ______________

Grade ______________

Period ______________

Date ______________

Learning units or jobs
Projects

Names of students								

STUDENT'S RECEIPT (Form)

STUDENT'S RECEIPT

WEST JUNIOR HIGH SCHOOL

Name ________________________________ Date ______________

Paid for ____
Project or materials

Amount ______________ Received by ________________________

MACHINE OPERATING PERMIT (Form)

MACHINE OPERATING PERMIT

Name____________________________________has completed all requirements for operating the power equipment listed below. All operating tests and safety tests have been satisfactorily completed.

This permit is for operation of the ______________________________

Date ______________ Instructor ______________________________

This permit will be revoked if any of the operational procedures or safety instructions pertinent to this equipment are violated. Re-instatement of this permit will be at the discretion of the instructor.

PARENT'S SLIP (Form)

PARENT'S PERMIT SLIP

Name ____

has my permission to operate the machines and tools in the Industrial Arts shop for the year 19 -19

In case an accident occurs we prefer that he receive medical treatment

from Dr. ____
Office phone Address

____
Signed by his parents or legal guardian

Date ________________

Following are generally accepted methods for efficient collection of materials used in the industrial arts shop:

1. Student punch card:

   Purchased in the office with a face value of $1.00 to $3.00. Deducted amounts are designated by punching around the edges of the card. Similar to conventional meal ticket. The instructor punches out the charges for supplies used by the student. This should be done in the presence of the student to enable him to continuously audit his account. Each student pays a specified amount which will vary with the various shop areas.

2. Annual accounting of funds:

   All money collected in the industrial arts department should be accurately accounted for, and turned over to the proper officials.

Discipline as a Method of Teaching and a Factor in Shop Organization

A good philosophy of discipline must be apparent throughout the entire school. It becomes the duty of every staff member, including the Industrial Arts personnel, to implement this philosophy in classrooms, shops, halls, and on the playground.

The best disciplinarian is one who is able to prevent discipline problems from arising rather than one who continually searches for a successful system of punishment to control misbehavior. Negative discipline, depending on strong-arm rule, should never be considered. Rather, the stress should be placed on the development of self-discipline. Positive goals should always be emphasized. Through these positive goals attitudes that will be carried with the student into adult life, allowing him to live cooperatively and successfully with others within the restraints of society, will be formed.

A good form of student government in the school and a personnel organization in the shop both help considerably in developing self-discipline. This self-control by the pupils in turn provides the proper teaching conditions for the classroom.

Discipline may be thought of as character education, providing for the development of attitudes, ideals and understanding that result in self-discipline as an adult.

Factors which help promote and encourage self-discipline in each individual student are found in the instructor, in the physical plant, and in the curriculum.

The Instructor as a factor in discipline:

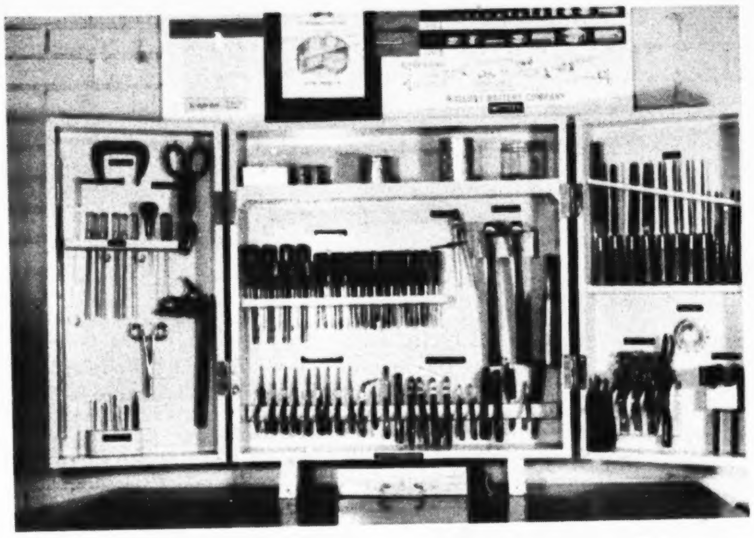
1. Is well-trained in subject matter field.
2. Demonstrates with skill.
3. Learns student names quickly.
4. Is friendly and enthusiastic, taking a personal interest in each pupil.
5. Sets clear limits for behavior and helps students understand these limits.
6. Does not use sarcasm, but speaks emphatically and firmly.
7. Provides rules with explanations.
8. Gives compliments often.
9. Helps children understand mistakes.
10. Takes an interest in pupil hobbies and out-of-school interests.
11. Does not use threats, force apologies, or give penalties without considering individual differences.
12. Examines the background of each student for further understanding.
13. Encourages each child to work for his own self-approval, rather than approval of his peers or fear of punishment.
14. Has sense of humor.
15. Provides a grading system that is fair and understood by students.
16. Utilizes all known successful record and instruction sheets.
17. Continues his professional growth by studying and by joining professional organizations.

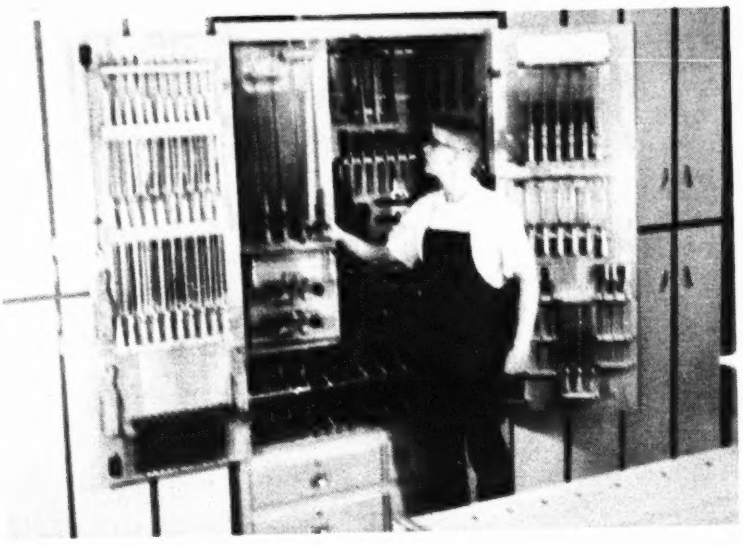
The physical plant as a factor in discipline:

The shop should be an attractive, comfortable, and pleasant place in which to work. An atmosphere of learning activity and productivity should prevail. Interesting and functional projects should be used in the course of study. A student must believe in what he is doing. The Physical Plant as a factor in discipline:

1. Provides ample storage space for projects. Damage and theft are discouraging to morale.
2. Is clean and well-lighted.
3. Provides for proper ventilation, temperature, with fans to draw out smoke, dust, etc.
4. Includes tools and machines that are kept in excellent working order. Dull tools create dissatisfaction.

5. Provides comfortable work space for each student. Overcrowding lively youngsters asks for discipline problems.
6. Provides a well-organized tool room or tool panels, accessible to students.





7. Provides facilities for lectures and tests.
8. Provides for a planning area including books, magazines, drawing equipment, etc., considered as the shop library.

The Curriculum as a factor in discipline:

1. Is carefully planned and challenging, meeting the needs, interests and abilities of the students in their school and community.
2. Includes interesting and functional subject matter with student appeal.
3. Provides flexibility and variety to meet student needs as follows:
    a. Variety of projects
    b. Interesting displays
    c. Well-planned demonstrations
    d. Slides, movies, field trips and speakers from industry. A check of the school faculty will provide a surprising number of resource people with hobbies, interests, and degrees in fields other than teaching.

Providing Adjustment for Individual Differences

Each student is a unique personality. All students vary in intellectual, social and emotional levels of development. Provisions must be made for each to develop to the fullest extent possible. The industrial arts program has much to offer in providing for individual differences. Its varied program of instruction in which the student has opportunities to explore many different activities provides a good foundation for more specific experiences at the secondary level. It is just as important to a student to find his weak points as it is to determine his strong points. Narrowing the fields of choice as progress is made through the secondary school makes final selection easier.

Interesting instructional material and projects at different levels of difficulty should be available in all industrial arts classes. Special provisions should be made for the slow and bright students as well as the average. Projects suitable to some members of the class may not apply to all. A variety of projects should be presented to the beginning student covering the same basic operations. This allows room for selection from the very beginning and creates interest. The faster student should be allowed to select projects (guided choice) upon completion of minimum requirements. He should be allowed and encouraged to do extra work such as developing a notebook in areas of interest, taking charge of bulletin boards, writing to industrial companies for literature, accepting positions of responsibility in the personnel organization of the shop, giving oral reports on related information and assisting slower students with their work.

For the slow learner, emphasis should be on "learning by doing." Every student must receive recognition and gain some measure of success and satisfaction. The alternative is frustration if the student is not guided according to his or her ability.

The shop atmosphere is also important in promoting individual differences. A pleasant, friendly atmosphere of learning should prevail. This, together with constructive discipline, are conducive to development of well-adjusted students. (See section on "Discipline as a method of teaching and a factor in shop organization" pp. 24-25.)

Ending the School Year

As in any successful venture, details must be planned to the very end. This is especially true in programs dealing with young people. The wise instructor will cope with the let-down attitude that inevitably permeates a school during the last few weeks of the semester with unflagging attention to good planning. Every day, including the last, must be carefully planned.

Advantages of an orderly finish are excellently summarized by Ericson:

1. Students receive additional knowledge and experience and acquire insight into valuable lifelong habits.
2. Students who leave the shop not to return carry with them a respect for the work and for the teacher.
3. Students who return will be in better frame of mind to start in the right way, and will reap the profit of their work done at the close of the year.
4. Visitors, of whom there are many during the closing days, including prospective students, form a good opinion of the conditions maintained.
5. The teacher is largely relieved of the work which he otherwise would be obliged to do before the beginning of school.
6. It will be easier to start the work properly when classes return.[1]

Planning for these final critical weeks should start several months before they actually arrive. Two check lists will be helpful in pinpointing the end-of-year needs of the instructor in regard to the students and in regard to the shop.

An instructor's check list of things he should do is as follows:

1. Set definite standards so that there is no misunderstanding in regard to what is expected from each student through the final day of classes.
2. Stress completion of all projects with quality, providing after-school time for work if necessary.
3. Place limitations on projects you are sure students cannot complete, making sure end-of-year costs do not become excessive.
4. Arrange a list of maintenance jobs for students who finish early, as well as a list of small, new-interest projects. Loafing during the last few days destroys an otherwise successful year. Specific maintenance projects include:
    - a. Sand and refinish benches.
    - b. Oil hand tools.
    - c. Oil machines and loosen or remove belts.
    - d. Clean finishing room, close paint cans, clean brushes, scrape bench top of old paint and repaint walls.
    - e. Straighten storage and supply cabinets.
    - f. Build new bulletin board or other small conveniences for shop.
    - g. Repaint machines using color dynamics.
    - h. Eliminate excess and unusable materials.
    - i. Clean and polish sink area and fountain.
    - j. Remove bulletin board material.
    - k. Remove, dust, and store displays, models and teaching aids.
    - l. Have students pay bills for supplies.
    - m. Remove projects from shop.
    - n. Dust and store books, magazines and instructional material. Separate those in need of repairs.

A check list of administrative and maintenance duties might be as follows:

1. Prepare the annual inventory.
2. Prepare and submit the annual requisition.
3. Bring all shop records up-to-date.
4. Prepare a list of equipment which needs maintenance during the summer.
5. Check all hand tools for repair.
6. Arrange to have damaged or worn books repaired.
7. Arrange to have machine and hand saws sharpened.
8. Revise and store all instructional material.
9. Pull main switch on power tools and lock.
10. Make out grade cards and permanent record sheets. Most schools issue instructional sheets on the closing administrative details.[2]

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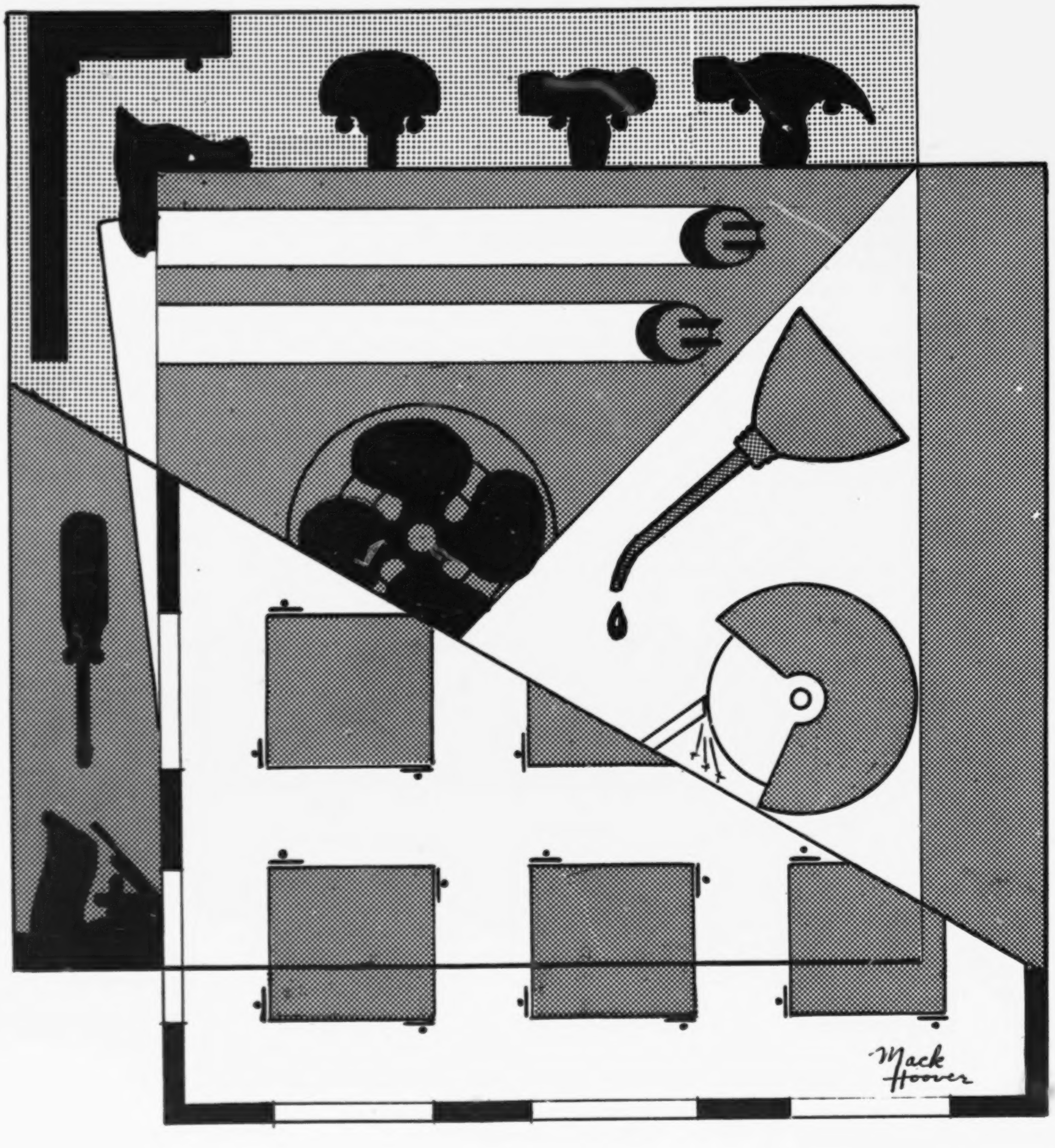
SHOP PLANNING & MAINTENANCE


Mack Hoover

CHAPTER IV

SHOP PLANNING AND MAINTENANCE

With present day enlightened thinking concerning Industrial Arts Education among school administrators, shop planning has become an important part of the over-all plan when considering the building of a new school plant or the modernization of an old one.

Location and Accessibility

The location and accessibility of the shop should be determined to a great extent by its use. For example, it is desirable to locate a woodworking shop or a metal working shop where delivery trucks will have easy access for unloading. It is also desirable to have these shops placed so that walls or other obstructions will not interfere with large projects such as boats or trailers being taken in or out of the shop. Obviously these would not be considerations in the location of a drafting room or a craftroom.

Noise is a characteristic of most shops. For this reason it is necessary to locate them away from areas of the school where noise would be distracting to other classes. In many schools they are placed in a wing with the music department.

Generally shops should be located on the ground floor. This provides for easy installation or removal of heavier machines, and facilitates the handling of bulk supplies such as lumber or steel. Basements are poor locations for shops because natural lighting is seldom good and ventilation is apt to be poor. Machines and tools are more subject to rust in basements.

Auxiliary Facilities

To be most effective certain auxiliary facilities are necessary in the shop.

1. The Lecture area: A place must be provided where students can assemble for lectures, demonstrations, group instruction, taking tests and other activities of this nature. Ideally this would be a separate room adjoining the shop or possibly between two shops. It has been found, however, that an open space large enough to accommodate chair desks with at least ten feet of blackboard space makes a satisfactory lecture area. In craft and similar shops where students work seated at tables, the lecture area may be dispensed with.

2. The Assembly area: Where large projects are likely to be built, some place in the room should be provided for assembling these projects. Preferably it should be located where the natural light is good and where assembly will not interfere with the use of machines or the normal flow of traffic. Approximately 10 per cent of the shop space should be available for assembly.

3. The Finishing room: In addition to furnishing a dust proof space where projects may be finished, this room should provide space for storing projects while undergoing the finishing process. The National Board of Fire Underwriters and most local fire departments have very strict specifications for the construction of these rooms particularly where spray finishing is to be done.

A separate spray booth must be provided for spray finishing. All switches, lights, and motors, both in spray booth and finish room must be explosion proof. The spray booth must be built of non-combustible material and the inside walls should be smooth and non-porous. Booth must be equipped with a filter equipped door, an exhaust filter, and an exhaust fan capable of moving 100 linear feet of air per minute across the horizontal cross section of the booth.

4. Storage: Two kinds of storage need to be provided for in-school shops. Storage for supplies must be provided and some place to store student projects during construction will be needed.

Generally it is more satisfactory to store lumber and rolled steel stock horizontally. Where space is a problem these may be stored vertically.

In vertical storage the length of stock that may be stored is limited by the height of the ceiling, often necessitating cutting the material before it can be stored. This not only takes time, but results in more waste. Lumber is more prone to bend and warp when stored vertically. This is particularly true of plywood which should be stored flat if possible.

Some provision for storage of small items such as bolts, screws, nails, hinges, and jewelry findings, is very necessary, but is often overlooked in the planning of a shop. Needless to say, provision should be made to keep all supplies under lock.

Ideally a storage locker with lock should be provided for each student. These should be large enough to accommodate the unassembled parts of the largest projects that will be made. Where projects are quite large it is sometimes desirable to have at least a few large lockers to hold larger pieces, and it is customary for several students to share the larger lockers.

5. Other Facilities: Every shop should have a place for students to wash and most shops also need some place to wash brushes and other dirty equipment. A sink that is to be used for cleaning should be equipped with a special trap which will allow easy cleaning. The round or semi-round Bradley type wash basins are satisfactory for washing but they require considerable space and are expensive. They are not satisfactory for cleaning brushes. A drinking fountain in connection with the sink is a desirable facility that is often overlooked in shop planning. At practically no cost this item will save the teacher much of the bother that accompanies students leaving the room to get a drink.

Gas lines and air lines should be provided in metal shops, machine shops, wood shops, auto shops, electric shops, and craft shops. These lines are much easier and cheaper to install if they are included in the original building plans. It is sometimes very difficult to get them into a shop after it is built.

Equipping the Laboratory

Since all school shops are equipped on a limited budget, care must be used in the selection and purchase of tools and equipment. In determining what equipment to purchase, the following factors should be kept clearly in mind:

1. *The underlying purpose of the program:* The objective to be achieved with the activities which will promote their attainment is an important consideration in the selection of shop equipment. Equipment for a program where trade classes are to be held in the evening should be as nearly the same as used in industry. Where the aims of the program are largely appreciation and understanding of industry, lighter duty machines generally can be used.

2. *The maturity level of the students:* Equipment for a seventh grade exploratory course in woodwork would naturally differ considerably from that selected for an advanced high school course.

3. *The type of shop organization:* If a central shop is being considered instead of a unit shop, the amount of each kind of equipment needed will be less, but a greater variety of equipment will be needed.

4. *The class size:* (see chart)

RECOMMENDED NUMBER OF SQUARE FEET PER STUDENT
FOR A CLASS OF TWENTY-FOUR, NOT COUNTING AUXILIARY ROOMS

JR. HIGH SCHOOL	MINIMUM	SATISFACTORY	DESIRABLE	%TO BE ADDED FOR AUX. ROOMS
Woodwork	60	75	90	30
Metal work	60	75	90	25
Drafting	45	60	75	5
Crafts	50	65	80	10
General comprehensive	60	75	90	25
Power mechanics	60	75	90	20

HIGH SCHOOL	MINIMUM	SATISFACTORY	DESIRABLE	%TO BE ADDED FOR AUX. ROOMS
Woodwork	70	85	100	30
Metal work	65	80	95	20
Drafting	60	75	90	5
Crafts	55	70	85	10
Graphic arts	60	75	90	20
Electric shop	60	75	90	15
Machine shop	65	80	95	15
Power mechanics	60	75	90	10
Auto mechanics	80	90	100	20

5. *Room size:* Even though adequate room size may be provided for in the original planning, plans are often modified to keep the cost of a building within the budgeted amount, and floor area has to be reduced.

6. *The probable amount of money available:* It is desirable to plan the equipment list on the basis of the first five of the above considerations before considering the amount of money available. By starting with a complete picture of the ideal equipment, deletions may be more intelligently accomplished. The most important items can then be purchased, leaving those of less importance to be purchased at a later date.

The following considerations in the purchase of shop equipment will save money for the school and much grief for the teacher:

1. Hand Tools
   - a. Purchase only standard brand tools made by a reputable manufacturer. It is usually not necessary to buy the premium line of a given manufacturer, but it is best to avoid the cheapest or the home workshop line. The better tools will do their work better, require less frequent sharpening and repairing and will often outlast several cheaper tools. It is also easy to purchase regular parts for standard tools. This is seldom true of off brands.
   - b. Purchase tools which fit the students. Smaller planes, smaller saws, and smaller hammers should be provided for smaller students. This does not mean the toy sizes. Too small a tool is worse than one too large.
   - c. Try to determine the largest number of students who will be using a given tool at a given time. Use this figure as a basis for purchasing rather than using a tool list prepared by some other person.
2. Machine Tools
   - a. Machine tools should be purchased to satisfy the purpose for which they are to be used. A unit shop may require heavy, production type machines, while a general shop will probably require light or medium duty machines. Generally the light or medium duty machines are satisfactory for Industrial Arts shops, since trade preparation is not a major goal.
   - b. In machines as in hand tools it pays to buy only those of standard make, backed by reputable manufacturers.
   - c. Unit type machines are preferred to combination machines. Combining a circular saw, a mortiser and jointer on a single stand reduces the usefulness of the machine and creates safety hazards.
   - d. Be sure to purchase machines of the proper voltage. Many new buildings are now wired for 208 volts. Motors designed to operate on 220 or 230 volts will not operate satisfactorily on the lower voltage.
   - e. Grinding equipment should be provided with safety shields of safety glass or plastic.
   - f. All motors should be provided with some type of overload protection.
   - g. All machines should have individual motor drives, controls, and stands.

Equipment Layout

In locating the equipment in a new shop or relocating equipment in an old shop the following procedure will be found helpful. Make a scale drawing of the room to be used showing all doors, windows, and other structural details which might affect the placement of equipment.

Prepare scale cutouts of all major pieces of equipment, including machines, benches, and cabinets. These cutouts may then be moved about on the scale drawing to determine the best arrangement of the equipment.

In arranging equipment first consideration should be given to making the arrangement as safe as possible. This means wide traffic aisles (forty-two inches is a good width), ample space around machines, a minimum of crisscrossing traffic, and good natural lighting on work areas. In the regular pursuit of his work it will often be necessary for a student to move from his station to other areas where things are stored for his use. These lines of travel should seldom cross other lines of travel.

Aside from safety the next most important consideration is the proper flow of stock being worked.

The normal flow of stock through the woodworking shop would be from cutoff saw to planer, to jointer, and then to bench saw. It is logical then to arrange these machines so that the stock will move smoothly out of the stockroom and through the machines with a minimum of effort or travel by the worker.

Remodeling Existing Facilities

A teacher is more likely to have a chance of remodeling an existing shop or turning an existing room into a shop than he is to get to plan a new one. In such a case the location, size, shape, and proportions of a shop are already established. A number of things, however, can be done to make an old shop into an adequate avenue of learning.

1. The artificial lighting can usually be improved by installation of flourescent fixtures.

2. Work places and machines can be rearranged as suggested.

3. New doors and windows can often be cut.

4. Partitions can be removed, or new ones put up to create needed auxiliary rooms.

5. Walls and ceilings can be painted to improve natural lighting and appearance. It is highly recommended that when repainting, one of the accepted color schemes such as "Color Conditioning" or "Color Dynamics" be followed.

6. Reconditioning floors.

7. Providing additional utility outlets.

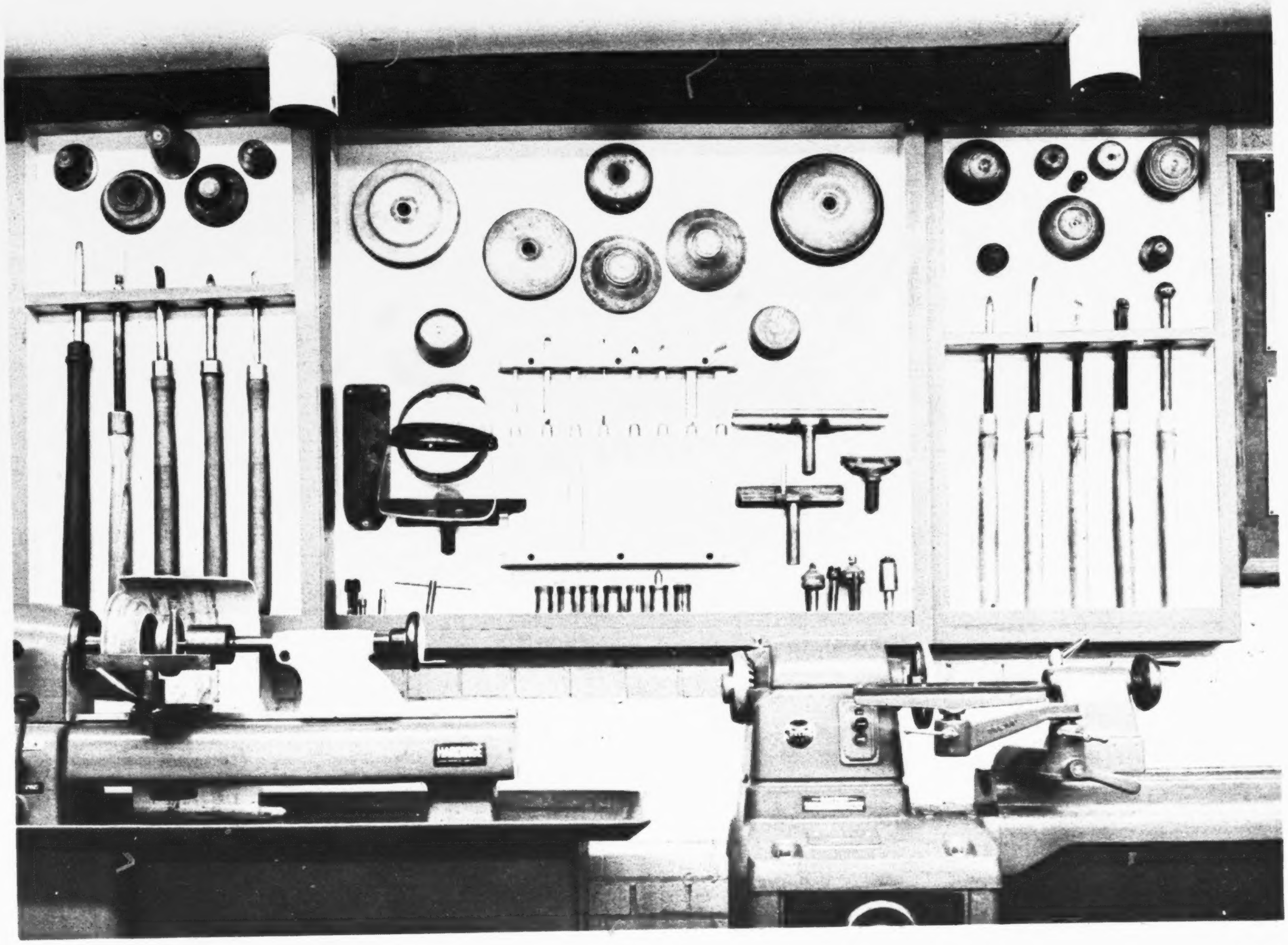
Space Per Student

Areas of shops are determined by the activity involved, by the grade level they are to serve and certainly by the amount of money available. Generally shops are much more likely to be too small than too large. In planning shops it is customary to allow so many square feet per student as a starting point in drawing plans.

The following table shows desirable, minimum and satisfactory areas per student for various courses, based on a class size of twenty-four students. In general the smaller the class the more footage per student is needed.

It is recommended that shop length be approximately twice the width.

Many shops make more efficient use of space by using wall panels for tool storage. A well-planned tool panel makes for ease of access, checking, and good display.



Care and Maintenance of Equipment

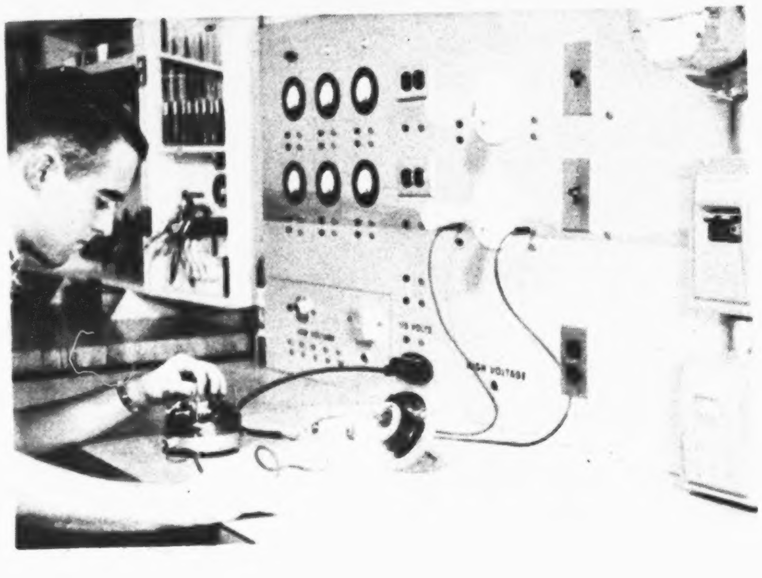
No one can do his best work with tools which are in poor condition, and certainly students are no exception. It is the duty of the shop teacher to see that all tools and machines are in first class condition at all times. Not only is this important from the standpoint of safety and good craftsmanship but it fosters the attitudes, and habits, which industrial arts promotes.

Hand Tools: Tool sharpening is perhaps the most frequently needed tool maintenance in any school shop. Teachers should know how to sharpen the tools in the shop. They should provide some system for periodic checking on their condition and see that tools are kept sharp and in good condition.

Handles of hammers, chisels, mallets, saws and planes should be kept tight and should be replaced when they are split or cracked.

Machines: A most necessary item of maintenance on machines is regular and proper lubrication. An expensive machine can be quickly ruined if bearings are allowed to run dry. A regular schedule for oiling machines should be established and this schedule should be followed religiously. Some teachers use a color scheme to accomplish this. Bearings which are to be oiled daily are indicated by painting the area surrounding the oil hole one color, those which need to be oiled weekly are painted another color, etc.

Excessive lubrication is to be avoided for it is messy and in some cases, particularly in motor lubrication, may interfere with proper operation. As a rule, however, it is better to over lubricate than to under lubricate. The local oil dealer can be helpful in determining the proper type and weight of oil or grease to use. Avoid detergent type motor oils for they affect the seals on some types of bearings.



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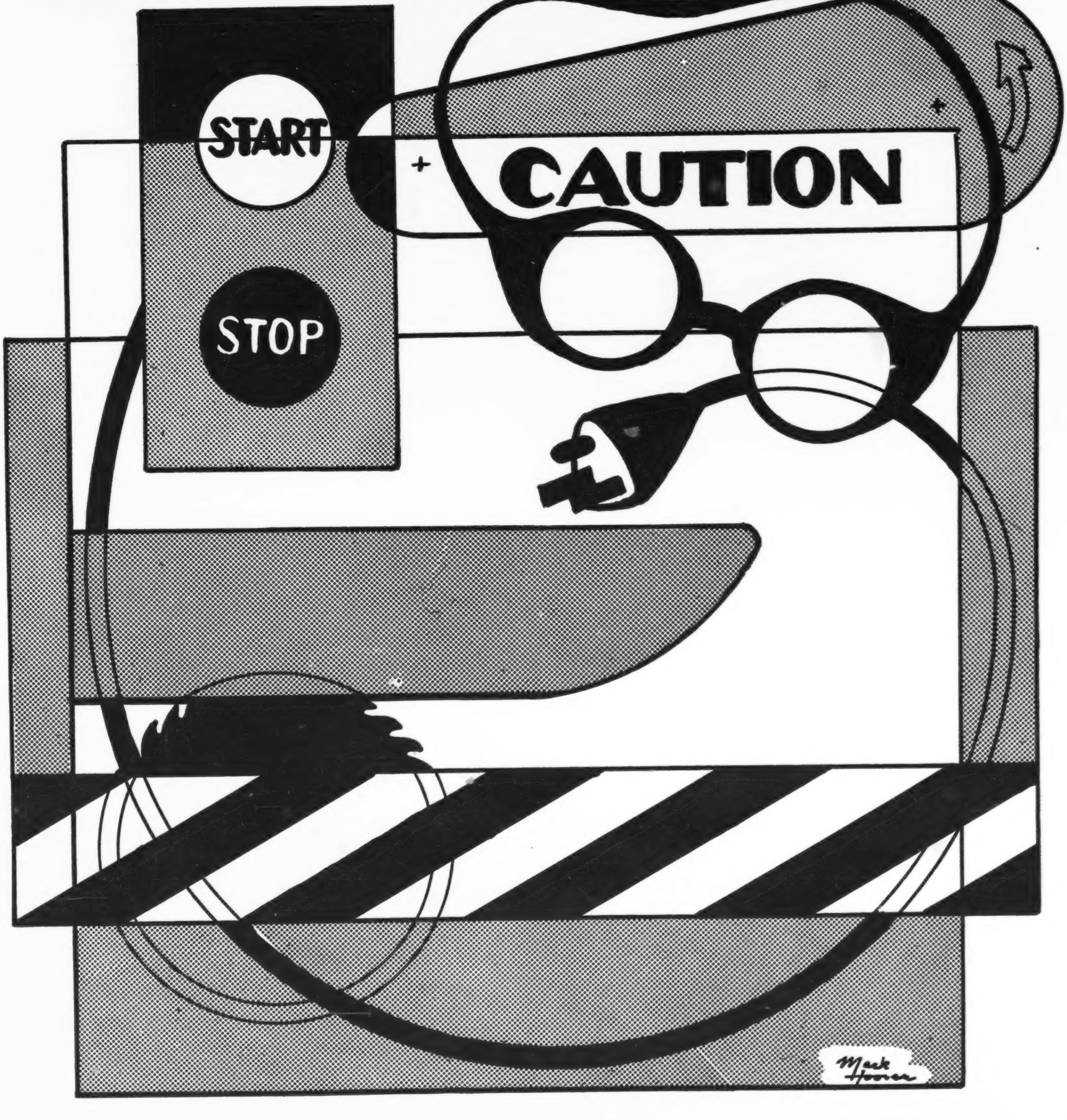
SAFETY


START
CAUTION
STOP
Mack Hoover

CHAPTER V

SAFETY AND LIABILITY

All industrial arts education teachers should be gravely concerned with student safety in the school shop. However, the larger class enrollments make it very difficult for the teacher to give the necessary individual attention to each student. Also the increase in the complex course offerings in the use of tools, materials, and processes make the job more difficult for the instructor. Even though these conditions exist, the teacher must not get a negative philosophy, "It can't happen to me." Shop teachers must be safety minded and have an alert awareness of all types of hazards. The teacher should continually ask himself this question: "Do I set a good example in safety at all times?"

Safety is an attitude accompanied by habits. The development of proper safety habits and attitudes is one of the primary objectives of industrial arts education teaching. An effective school shop safety program does not just happen. It is a result of careful and continual planning. The safety problems that confront the teacher are determined by the school laws of the state, philosophy of the school, the physical plant, and the organization within the system.

Simple policies and rules should be established and then must be enforced. In other words, there must be no compromise with safety. Nothing but a perfect score is acceptable, for the ultimate goal of safety instruction is to protect pupils from accidents due to their errors or lack of knowledge.

Positive safety education is based on accident prevention. Present day conditions make it imperative that safety education be a part of the training of all students; it should be a part of every course of study, and teachers should teach, practice, and display safety practices at all times.

Because of the legal liability and moral responsibility, it is good common sense for every shop teacher to prevent accidents by eliminating, as far as he can, all mechanical and physical hazards because these are tangible. Other phases of safety instruction are intangible, but nevertheless important in the over-all picture.

Positive safety instruction is self-preservation for the teacher, for the supervisor, and for the administrator. Safety is everybody's job. We should do an excellent job of safety instruction if we conscientiously follow Scott's safety check list.

SAFETY CHECK LIST

Attitude and Personality

Yes No

☐ ☐ 1. Do I think, speak, and act in regard to shop safety at all times?

☐ ☐ 2. Have I integrated my safety program with what I am teaching, in an interesting, logical manner?

☐ ☐ 3. Are my students keenly aware that shop safety is a vital, required part of my shop program?

☐ ☐ 4. Do I immediately curb *horseplay* and carelessness in the shop at all times?

☐ ☐ 5. Have I explained and demonstrated the need for cooperation among students and teacher when certain jobs of lifting, gluing of boards, and carrying of materials become necessary in the shop?

☐ ☐ 6. Am I acquainted with the school laws of state regarding shop safety, negligence, etc.?

Shop Dress

☐ ☐ 1. If students are required to wear shop coats or aprons, do I insist that they be

Yes No

kept neat, clean, and buttoned or tied at all times?

☐ ☐ 2. If students do not wear coats or aprons, do I insist that they refrain from wearing new or loose clothing?

☐ ☐ 3. Have I told the students the danger of wearing long sleeved shirts, neckties, jewelry, etc., and am I on constant guard to see that no one forgets?

Material Shortage

☐ ☐ 1. Is the material on lumber racks, metal racks, clamp racks, etc., stored neatly and safely at all times?

☐ ☐ 2. Are all materials stored in proper, convenient places and not left lying about in haphazard fashion?

☐ ☐ 3. Are all material storage places sufficiently lighted?

☐ ☐ 4. Do I guard against overstocking racks, shelves, etc.?

Hand Tools

☐ ☐ 1. Are my tool panels, tool room, etc., organized in a neat, safe fashion?

☐ ☐ 2. Have I told my students the danger of using dull hand tools?

☐ ☐ 3. Have I stressed the safety points on the various hand tools during my talks and demonstrations and am I on constant guard to see that the student participation is done correctly?

☐ ☐ 4. Have I explained and demonstrated the correct procedure for carrying sharp edged tools?

Machinery

☐ ☐ 1. Is each machine properly located in respect to space, efficiency, and safety?

☐ ☐ 2. Are all cutting edges, belts, pulleys, etc., carefully guarded?

☐ ☐ 3. Is there adequate light for the safe operation of each machine?

☐ ☐ 4. Are the machine accessories, for each machine, placed in the proper location? (Avoid reaching over running machines for needed accessories.)

☐ ☐ 5. Are all machine switches guarded and properly painted?

Yes No

☐ ☐ 6. Are all machines clean and properly painted?

☐ ☐ 7. Are goggles a necessity for the operator of certain machines such as grinders, lathes, etc.?

☐ ☐ 8. Have proper safety rules and demonstrations been shown, studied, and talked about informally for the operation of each machine before any student participation?

☐ ☐ 9. Is student participation on each machine an individual affair, whereby each student must qualify by passing tests?

Finishing Room — Acids

☐ ☐ 1. Is there proper ventilation in the finishing room?

☐ ☐ 2. Is there a special booth for spraying, if much spraying is done?

☐ ☐ 3. Are large quantities of combustible materials kept in fireproof rooms or closets?

☐ ☐ 4. Are oily rags and waste kept in proper recepticales?

☐ ☐ 5. Is the finishing room kept neat and clean at all times?

☐ ☐ 6. Are all containers closed tight and stored away from heater pipes or radiators?

☐ ☐ 7. Are acids and other harmful agents used in the shop kept in proper containers and clearly labeled and are they stored in a safe place?

General Safety Rules

☐ ☐ 1. Is the shop well lighted, clean, free of grease and oil on the floor, and neatly painted?

☐ ☐ 2. Does each machine have an adequate safety lane area painted on the floor?

☐ ☐ 3. Are all light switchs in good working condition and of the right type for each part of the shop? (For instance: mercury switches in the finishing room.)

☐ ☐ 4. Have all lines and electrical circuits been checked for proper load?

☐ ☐ 5. Are all plugs and extension cords in good condition? (No splices or poorly taped wires.)

☐ ☐ 6. Are you familiar with all fuse panels for your shop? Are proper fuse loads always maintained?

Yes No

☐ ☐ 7. Have the fire extinguishers been checked recently and are they of the right type for each part of the shop in which they are located?

☐ ☐ 8. Do I help promote shop safety by keeping pleasant board displays?

☐ ☐ 9. Do I have a fair knowledge of first aid and what to do in case of an accident?

☐ ☐ 10. Is there a good first aid chest at my service in the event that I should need it?

☐ ☐ 11. Are insurance and accident report papers neatly filed and kept ready (just in case)?[4]

Should an accident occur in the school shop, the teacher may give first aid, notify a doctor or send the student to the school nurse. He should notify the parents or have this done from the school office. In addition, it is a growing practice to expect every teacher to make a preliminary accident report, and it should be kept on file until the person has reached legal age. The following is a suggested preliminary accident report:

Preliminary accident report to be filled out immediately after an accident in the shop.

School	Room .... Date ....
1. Who was injured?	Name .... Age ...... Address .... Tele. ....
2. On what day and what time did the accident occur?	Date .... Hour .... A.M. .... P.M. ....
3. What was the nature and extent of injury?	Nature of accident .... Nature of injury ....
4. Who gave medical treatment?	First aid in school .... Physician .... Nurse .... Hospital ....
5. Where did the accident occur?	The exact place in the shop where the accident occurred was ....
6. Who saw the accident or was near the injured when the accident occurred?	Name .... Age ...... Address .... Name .... Age ...... Address .... Name .... Age ...... Address ....
7. What was the cause of the accident?	Teacher's opinion ....

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[4] C. J. Scott, "Shop Safety Check List for Shop Instructors," **Industrial Arts and Vocational Education**, XLVII (April, 1958), pp. 126-127.

When an accident occurs in the school shop the teacher must be able to show sufficient evidence that he consistently maintains all reasonable safety precautions, or he is liable. The general agreement among authorities on school law is that teachers will likely be considered negligent under the following conditions, if an accident occurs in the shop:

1. Teacher fails to demonstrate safe techniques and practices for each individual piece of equipment.

2. Absence of teacher from shop while pupils are in the shop.

3. Teacher leaving the shop, with an unqualified person in charge of the class.

4. Pupils using equipment in the shop which has not been approved by the board of education. Some teachers bring their personal equipment to the school shop.

5. Permitting pupils to work in the shop other than during the regularly scheduled periods and especially without acceptable supervision.

6. Permitting pupils not enrolled in shop classes to use the equipment.

7. Pupils being sent outside the shop to perform hazardous duties.

8. Making the use of all power tools compulsory.

9. Allowing pupils, especially prone to accidents, to use power machines. Some physical and some mental conditions should make a pupil ineligible insofar as the use of some power tools is concerned.

10. Failure to keep written reports of every accident occurring in the school shop regardless of the type of injury.

11. Failure to administer safety tests and to retain such satisfactorily passed tests for use in case of liability suits charging negligence. To some teachers the term "satisfactorily passed" means 100 percent correct or the student doesn't use the equipment.

12. Failure to get written statements from witnesses in case of accident.

13. Failure of the teacher to keep in mind the fact that his or her pupils are children and that the actions of children are normally guided by childish impulses.

14. Failure to realize that the case mentioned above is defined by law as greater caution when dealing with children than with adults.

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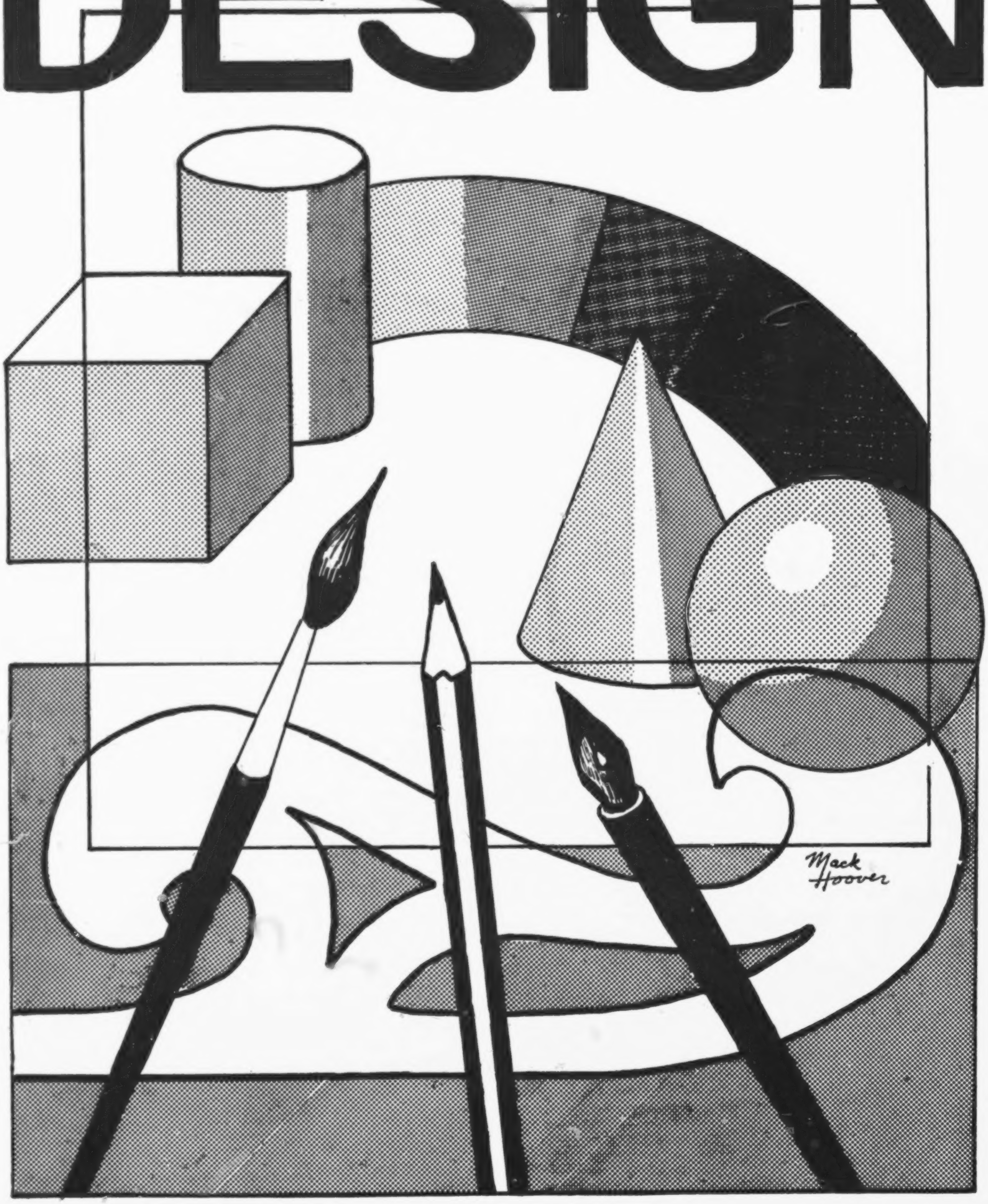
DESIGN


Mack
Hoover

CHAPTER VI

FUNDAMENTALS OF DESIGN

Design is probably one of the least understood fields connected with the industrial arts. It is a field that is constantly changing. The teacher should be aware of new ideas and try to incorporate them into his teaching to keep his designing up-to-date.

The average industrial arts teacher feels that design is something for which he has little or no talent. However, this same teacher could improve his ability to design even though perhaps he does not possess a natural artistic ability. It is true that artistic ability is a great help to the designer; however, a thorough knowledge of the fundamentals of design will not only help the average industrial arts teacher do a satisfactory job of designing, but is essential before the artist can become a good designer. If a knowledge of the fundamentals of design can be of help, then let us in industrial arts study these fundamentals to do the job we are doing to the best of our ability.

Kinds of Design

In designing, form must follow function. A car, no matter how beautiful, is worthless unless it will run. Too much of our design has been bound by the past and therefore has been retarded. For instance, the first car was shaped like the buggy instead of having the sleek lines we know today.

There are two important types of design, structural and decorative. Of these two, structural design is much more important.

1. Structural design: Structural design refers to the shape and size of an object and will vary enormously depending on what the object is to be used for. Some of the principles to follow in structural design are:

   a. It must be adapted to the use for which it is intended.

   b. It must be simple.

   c. It must be well proportioned.

   d. It must be suited to the materials of which it is made and the processes necessary in making it.

Some examples of good structural design are the airplane or the San Francisco Oakland Bay Bridge, in which the design is a result of the object's function.

2. Decorative design: Although decorative design is the lesser in importance of the two types, it is still important to good design. Some of the principles of good design are:

   a. Decoration should be in moderation.

   b. Decoration should strengthen the object.

   c. Decoration should be placed at weak spots.

   d. Background areas should be the same size.

   e. Background space should give simplicity.

   f. Decoration should be suited to the material used and the use of the object.

Elements of Design

The elements of design are line, shape, size, texture, value and color. It is with these tools that the designer must work.

1. Line: Every design is made up of lines which vary as to width, texture, direction and extent. The principles give line its meaning. For example, the direction of the line may be vertical, horizontal, curved, or zigzagged. The vertical line appears to be direct, tense, stiff, uncompromising, harsh, hard, unyielding; while the horizontal line has a slow, lazy appearance.

The zigzag line denotes excitement or nervousness. The weight, texture, and extent of a line can also be used to set the mood for design.

2. Shape: Every design is made up of some part of the triangle, rectangle, square, circle, cone or ellipse. It is the proper blending of these shapes that produces our good designs. Almost every person can produce each of these and, like building a complex piece of furniture, from simple operations the designer can produce the desired results by putting these simple shapes together.

3. Size: Size refers to the measurement of an object. In the field of industrial arts, we most often find size as a standard measure that has been worked out to fit the needs of the average size person. Almost any catalog is a good reference for the standard size of a given object.

4. Texture: Texture is the minute structure of a material. Texture appeals to the sense of touch. It may be rough or smooth, pebbly or prickly, or satiny or velvety.

Texture also has great appeal to the sense of vision. By association of visual experiences with tactile experiences, we say a surface looks wet or dry, rough or smooth. Because of the importance of texture, manufacturers have in recent years introduced new materials such as glass blocks, corrugated sheet glass, chromium, plastics, sponge rubber, metallic paper, and cellulose fabrics; texture has become a richer, more versatile element that has expanded the scope of the designer.

5. Value: Value is the quality of visible light reflected by a tone. It is lightness or darkness of tone. For example, we refer to green as light green or dark green — both are greens but there is a difference in their value.

6. Color: Color must be a factor in design because color affects us psychologically. For example, red is an active color while brown suggests restfulness. Color also has the suggestion of warmth or coolness. Such colors as yellow, orange, and red appear warm, while blue, green, and violet appear cool. The designer, in order to produce the desired results, must consider all of the above elements.

Principles of Design

The principles of design include balance, dominance, unity, proportion, and repetition. They are the factors that make a design have a good appearance.

1. Balance: Balance is the result of the interplay of forces; the resolution of stress and strain. Its effect is one of repose and satisfaction. Lack of balance creates a desire for change. The designer uses the following methods to obtain balance:

- a. Through giving evidence of adequate strength.
- b. Through functional relationship of all parts.
- c. Through equalized arrangement with respect to an axis, a center of interest, or a line of motion.

2. Dominance: In good design, some part of the design must be dominant or stand out among the other parts. If there are several dominant parts, these parts must harmonize.

Dominance can be achieved by several methods such as: making one unit larger, making a unit stronger in value or different in texture or color. Dominance is also achieved by shape or repetition of some part of the object.

3. Unity: Unity is the tying together of parts of a designed object. Unity may be produced by a number of means, among which are the following:

- a. Through a clear evidence of function.
- b. Through reducing complex combinations of parts or elements to a relatively few simple forms.
- c. Through regular or sequential arrangement of elements.
- d. Through unity of style elements within a design or in related designs.

4. Proportion: Proportion is the law of relationships. Good proportions are the result of harmonious relationships of lines and of masses. Proportion should not be easily analyzed. Masses having the proportion of 2 to 3, 3 to 5, 2 to 5, 5 to 8, or similar ratios are good. This holds true in dividing areas as well as in the outside dimensions; however, this is not a hard, fast rule. The best proportions is that which best suits the use for which the object is intended. Some things to consider in proportion are:

- a. Arrangement must hold interest.
- b. Arrangement must be best for the sizes and shapes used.
- c. Sizes grouped together must be complimentary.
- d. Space relationships must be pleasing.
- e. Scale must be proportionate.

5. Repetition: Repetition is the using of some element of the design over and over to produce harmony. Some of the ways this can be achieved are through the repetition of color, parts of a project or in the processes used to make the article.

Qualities to Consider in Designing

Qualities that should be considered in designing are as follows:

1. The size and shape of the object.
2. The purpose the object is to serve.
3. The limitations of the material to be used.

4. The tools and processes necessary to produce the object.

How to Produce Good Design

1. Knowledge of fundamentals: A thorough knowledge of the fundamentals of design are essential to good design. Without this knowledge of fundamentals the designer is like the cabinet maker trying to make a piece of furniture without a knowledge of woodworking tools.

2. Steps in designing:

   a. There must be a need.
   b. Standard requirements must be known.
   c. The most suitable materials should be selected.
   d. The details of form, line, proportion, and construction must be decided. Sketches will help in doing this.
   e. The best of the sketches should be selected and a full-sized working drawing made from it.
   f. Proportion and details must be refined.
   g. The drawing should be checked.
   h. Revisions should be made where necessary.
   i. The article made from the drawings should be examined to learn how well the idea has worked in practice, and to see how improvement can be made on the next design.

How to Teach Design

1. Design through fundamentals: It is important that the student become proficient in the use of fundamentals of design. In order to establish this proficiency, the teacher should teach design fundamentals and provide ample opportunity for the student to practice these fundamentals through exercises dealing with the various areas.

2. Design as an aesthetic value: With practice and use of fundamentals of design, the student will eventually develop an appreciation for good design. This will help the student do better work and become more skilled in the designing of his projects. This aesthetic value, however, like appreciation, is a result of all we do rather than being something toward which we teach.

Summary

Structural and decorative are the two types of design with structural being more important than decorative. The factors which the designer must consider are line, shape, size, texture, value and color. A thorough knowledge of these tools is important to good design. The principles the designer must keep in mind when designing are: balance, dominance, unity, proportion, and repetition.

Some other qualities which must be considered in designing are: purpose, material limitations, and limitations of tools and processes in producing the object. The industrial arts teacher can produce good design through mastering the fundamentals of design and following definite steps in the actual designing.

Design can be taught through the teaching and student practice of the fundamental tools and principles of design. *Aesthetic values* will be a result of good teaching and practice. These aesthetic values will prove helpful to the student in determining what is good and poor design.

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EVALUATION

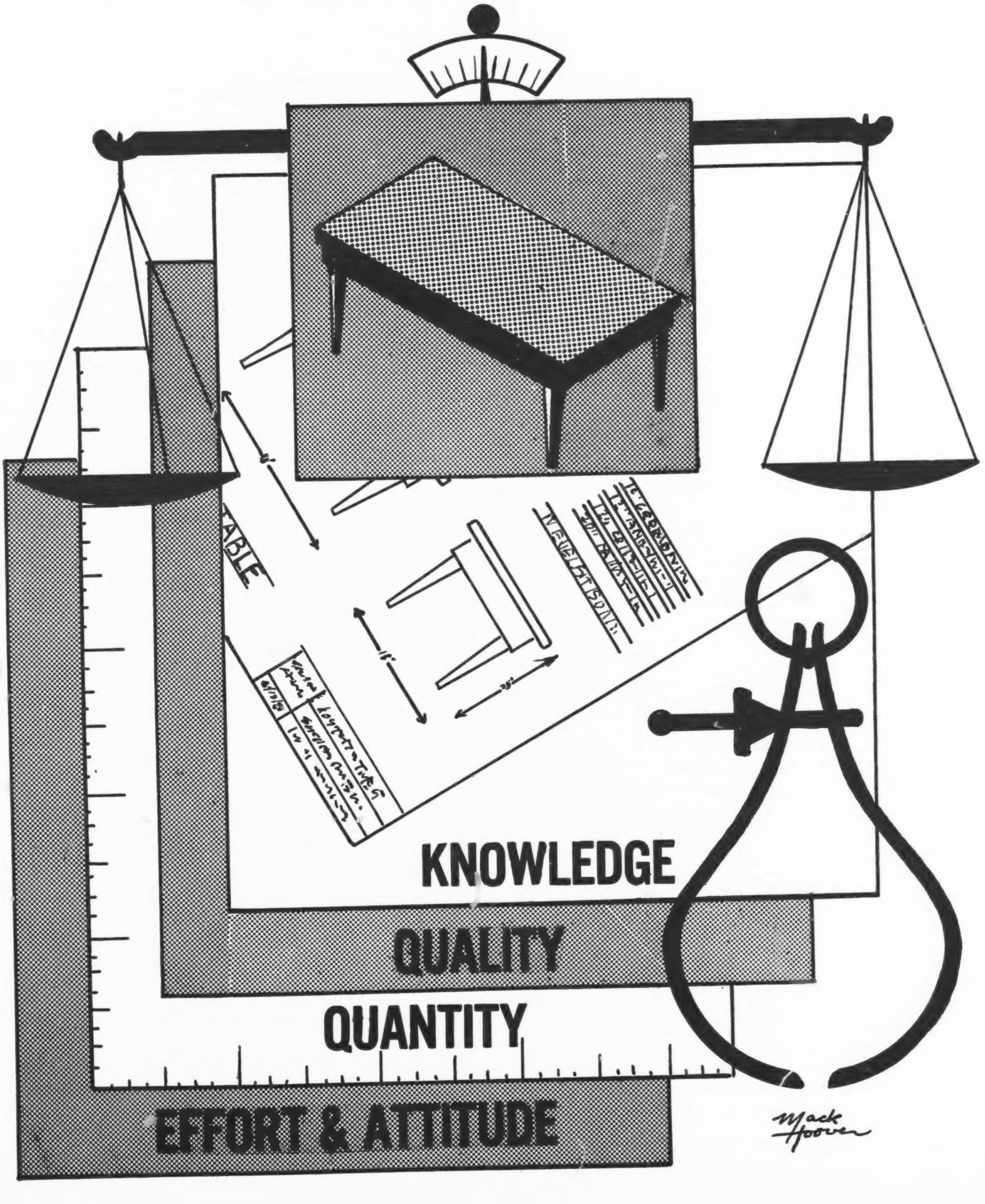
TABLE
KNOWLEDGE
QUALITY
QUANTITY
EFFORT & ATTITUDE
Mack Hoover

CHAPTER VII

STUDENT EVALUATION

Evaluation of student accomplishments in any course depends upon the purposes of the student and the objectives of the course. Types of marks must, of course, conform to those used throughout the local system. Some desirable characteristics of any grading system are as follows:

It should consume a minimum of the teacher's time.

It should be based upon a wide scope of student responses and attainment.

The grading should be frequent.

Uniform standards of grading should be applied.

Grades should be permanent.

If the course is exploratory in nature, evaluation should be indicative of the honest effort made on the part of the student to acquaint himself with a wide range of industries (offerings of the course), and his ability to formulate firm decisions regarding his interests and aptitudes in the various areas and processes. Although decisions of interest and aptitude may be positive or negative, the student's logic based upon his understanding of processes is a firm basis for grading. Quality of work in the exploratory courses should be considered only insofar as it indicates interest and attitude. Students should be evaluated in shop clean-up, class participation, interest, effort, open-mindedness and wholesomeness of attitude, cooperation, and soundness of decisions regarding areas and processes. If evaluation is frequent, changes and change trends in the marks given should be considered.

In general shop or unit courses (beyond the exploratory level) quality of work, quantity of work, general background knowledge, and technical knowledge should be measured. Shop clean-up, class participation, interest, effort, cooperation, and other applicable phases of attitude should also be evaluated. A generally accepted scale of four basic points is as follows:

Knowledge (general and technical)	25%
Quality of work	25%
Quantity of work	25%
Effort and attitude	25%

The knowledge evaluation should consider ability to plan and adapt acquired information, ability to follow instructions, tests (objective, performance, and subjective), ability to read drawings, and recitation.

Quality should include accuracy in proportion to ability, in proportion to class average, and in proportion to trade standards, neatness, and artistic ability.

Quantity evaluation should consider time factor in relation to ability, class average, thoroughness, and quality. Extra work above requirements of the course and extra work service in the shop should also be considered.

Effort evaluation should consider desirable habit formation, determination, perseverance, initiative, self-direction, honesty, dependability, use of time, attendance, and industry. Attitude evaluation is closely related to effort though a little more general in nature. It should include:

1. Cooperation with group and teacher.
2. Care and use of equipment.
3. Organization and pride in work.
4. General courtesy and respect for rules and general situation in the shop.
5. Observation of safety factors.

6. Respect for other students and their work.
7. Respect for authority.
8. Respect for finance.
9. Thriftiness in use of materials and equipment.

Percentages of the four points should be adjusted to fit the individual shop and objectives of the course.

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CHAPTER VIII

HISTORIC BACKGROUND AND CURRENT TRENDS IN INDUSTRIAL ARTS EDUCATION

A study of the history of industrial arts should, if it is to be of value, (1) aid us in solving present day problems in industrial arts education, (2) assist us in justifying our present practices, or (3) assist us in improving our program and practices in industrial arts education so that it may be fully justified as a part of the total educational program. The histories of "industrial arts education" and "industrial education" are one and the same until the Smith-Hughes Law was passed in 1917. (See illustration on page 48).

The industrial subjects in education in America have gone through some interesting changes in less than a century. Much was gained from these European experiments in this field of education. Those experiments were: The Russian Plan of Tool Instruction; The German Manual Training; and the Swedish Sloyd movements.

The Russian Plan of Tool Instruction (1868)

The characteristics and purposes of the Russian system were as follows:

1. For development of trade instruction (inaugurated by Della Vos of the Imperial Technical Institute of Moscow, Russia, in 1868).

2. To train engineers and skilled workers for building Russian railroads.

3. To organize industrial vocational education for groups (first attempt to such organization).

4. For formal instruction of a series of exercises, joints, models in wood and metal (did not contain the element of boy interest).

Influences of the Russian Plan were largely in the direction of organization and administration. The plan was not adopted in its entirety, but the following influences and practices have come down to us and are used today:

1. The course of study was based upon occupational analysis.

2. Courses built on principle of working from *simple* to *complex*.

3. Subject matter was organized for teaching purposes.

4. Teaching methods were developed.

5. Pupils were trained in groups rather than singly.

6. Progress of the student could be determined at any time.

7. Both *individual* tool sets and benches and *general* tools were included in the equipment.

8. Pupils worked from drawings they had previously made.

9. Separate shops were established for the different equipments or trades.

10. Models and charts were hung on the walls of the shops.

11. Time required for learning a trade was shortened from that required under apprenticeship.

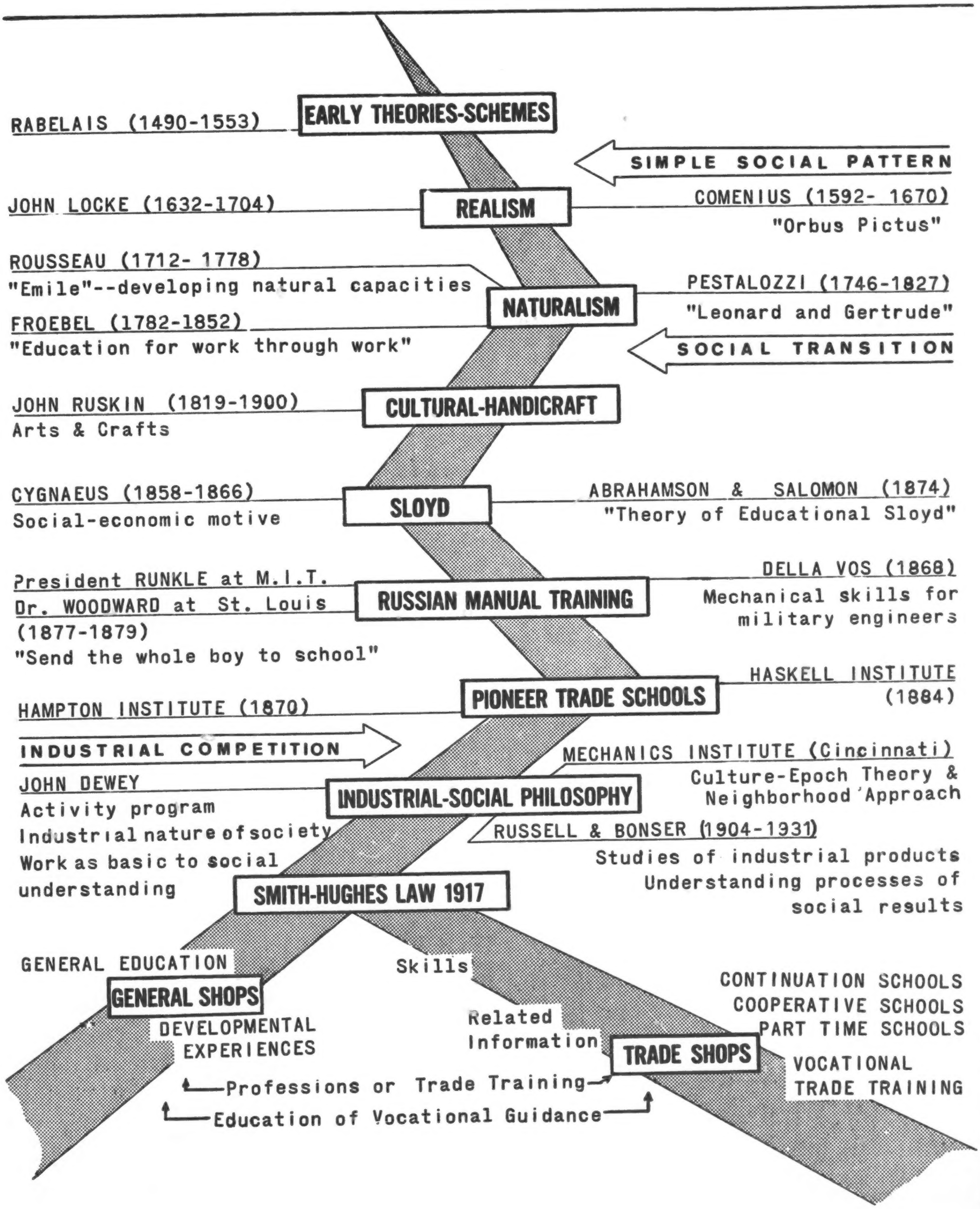
12. Accuracy required was increased as the course progressed.

13. One model was completed before another was begun.

The German Manual Training (1870)

The movement was developed by Dr. Waldemar Goetze for a distinctive type of manual training in Germany.

BEGINNINGS OF INDUSTRIAL ARTS



RABELAIS (1490-1553)

EARLY THEORIES-SCHEMES

SIMPLE SOCIAL PATTERN

JOHN LOCKE (1632-1704)

REALISM

COMENIUS (1592- 1670)
"Orbus Pictus"

ROUSSEAU (1712- 1778)
"Emile"--developing natural capacities

NATURALISM

PESTALOZZI (1746-1827)
"Leonard and Gertrude"

FROEBEL (1782-1852)
"Education for work through work"

SOCIAL TRANSITION

JOHN RUSKIN (1819-1900)
Arts & Crafts

CULTURAL-HANDICRAFT

CYGNAEUS (1858-1866)
Social-economic motive

SLOYD

ABRAHAMSON & SALOMON (1874)
"Theory of Educational Sloyd"

President RUNKLE at M.I.T.
Dr. WOODWARD at St. Louis
(1877-1879)
"Send the whole boy to school"

RUSSIAN MANUAL TRAINING

DELLA VOS (1868)
Mechanical skills for military engineers

HAMPTON INSTITUTE (1870)

PIONEER TRADE SCHOOLS

HASKELL INSTITUTE (1884)

INDUSTRIAL COMPETITION

MECHANICS INSTITUTE (Cincinnati)
Culture-Epoch Theory & Neighborhood Approach

JOHN DEWEY
Activity program
Industrial nature of society
Work as basic to social understanding

INDUSTRIAL-SOCIAL PHILOSOPHY

RUSSELL & BONSER (1904-1931)
Studies of industrial products
Understanding processes of social results

SMITH-HUGHES LAW 1917

GENERAL EDUCATION

GENERAL SHOPS

DEVELOPMENTAL EXPERIENCES

Skills

Related Information

CONTINUATION SCHOOLS
COOPERATIVE SCHOOLS
PART TIME SCHOOLS

TRADE SHOPS

VOCATIONAL TRADE TRAINING

Professions or Trade Training

Education of Vocational Guidance

Some of its influence in our industry today are:

1. Instruction was largely pedagogical and psycological.

2. Useful articles were made.

3. There were both class and individual instruction.

4. Organization of content was methodical.

5. Teachers were trained persons who received supplemental instruction in mechanics from skilled artisans.

6. Interests of students were capitalized upon.

7. The learning experience, through carefully directed doing, was emphasized as much as the content.

8. The program was given an independent place in the curriculum.

Swedish Sloyd

Characteristics and purposes of the Swedish Sloyd system were:

1. A Swedish Sloyder was a man skilled in many arts, primarily in wood (modeling with cutting tools more than other phases).

2. Chief purpose was social.

3. Social aim was to help raise the moral standards of boys, which had deteriorated with the factory system and the decline of the home Sloyd.

4. From occupational education viewpoint, the purposes were both general and specialized.

5. Influences of Sloyd on American education handwork are:
   a. Discipline was formal and a transfer of training was part of the underlying philosophy.
   b. Projects were useful and boy interest followed work of the exercise type.
   c. Drawings were made by the students.
   d. Aims established contributed to general education.
   e. Cultural values were recognized.
   f. Practice of making notes, sketches, and lists of operations in a notebook were inaugurated.
   g. Student had some choice in selection of project.
   h. Class instruction was supplemented by individual instruction.

Development of Industrial Arts Education in the United States

Calvin M. Woodward established the *Manual Training School* of Washington University in 1879, which followed closely the Russian Plan of Tool Instruction. He advocated handwork as a part of general education of all boys. School was largely vocational in nature in order to secure funds. They were aimed to train skilled mechanics and prospective junior executives. This system followed closely the Russian plan of instruction. Courses in wood, metal, and drawing were taught.

No clean-cut line can be drawn between the names "manual training" and "manual arts". The newer term contains the thought art and design. The designing of problems to be made in a school shop became an important part of educational handwork, and the true "educational project" was born. Influences of the manual arts era are:

1. Designing of problems became an important part of shop work.

2. Development of project method.

3. Shop work broadened into other trade, industrial and craft fields, than wood and iron.

A new concept was clearly brought about by Russell in 1909 and Bonser in 1911. The industrial arts concept was largely in terms of the elementary school level. Russell said, "Study of industries should be for the sake of securing a better view of man's part in controlling production, distribution, and consumption."

Well-defined influences resulted:

1. Related informative subject matter of industrial arts assumed a position of greater importance.

2. Consumer's values rather than producer's values became a controlling purpose.

3. It became more generally accepted as a branch of general education.

4. It became based on the theory that a wide sampling of industrial experiences was desirable.

5. In school work, industries and industrial life assumed greater importance.

6. The general shop and the general industrial arts course was born.

The character of the subject matter of industrial arts today lends itself unusually well to three important present-day movements in education in America: namely, individual differences, reasoning or problem solving, or correlation.

(Reference. John F. Friese, **Course Making in Industrial Education.** The Manual Arts Press, Peoria, Ill. 1946. pp. 43-55)

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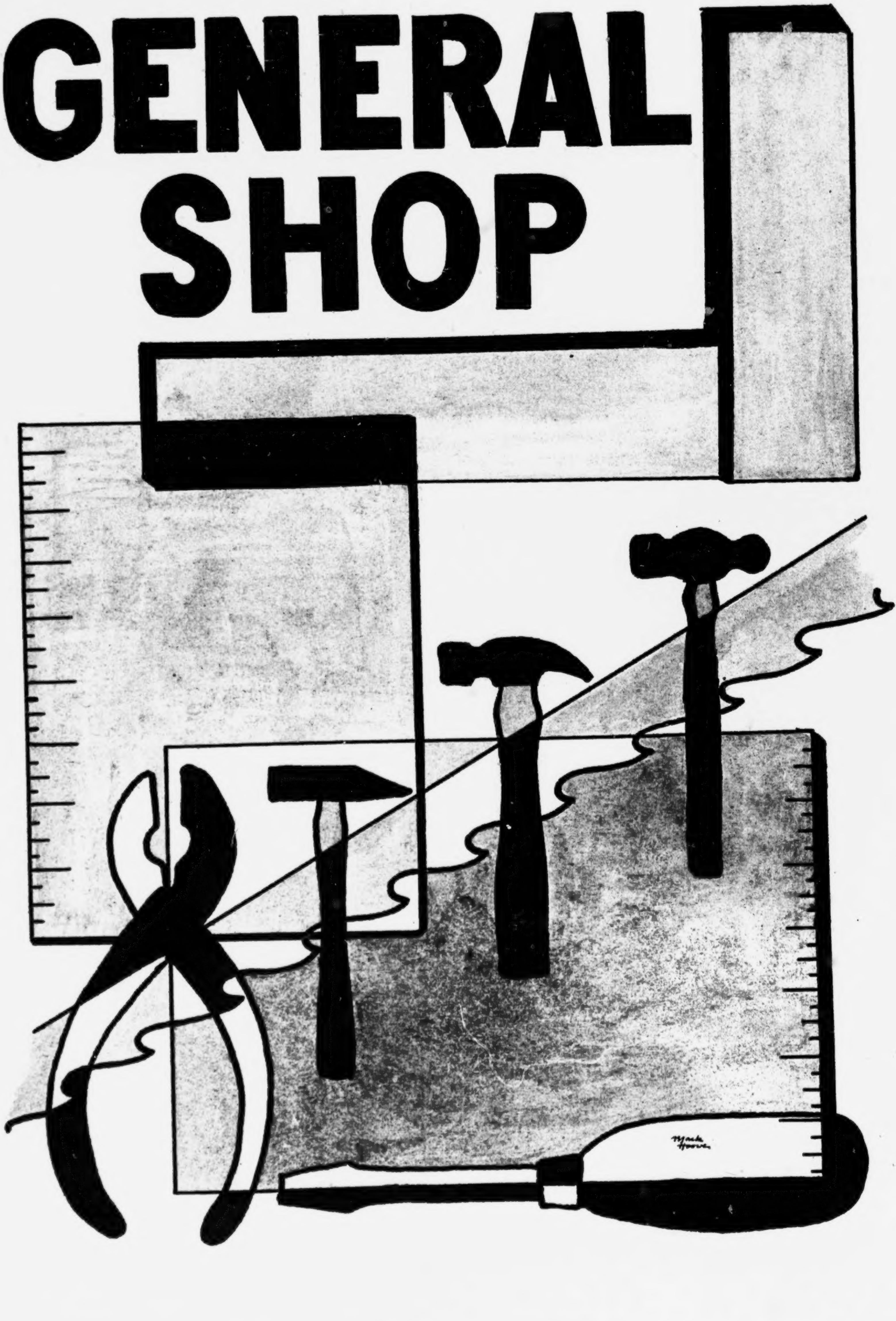
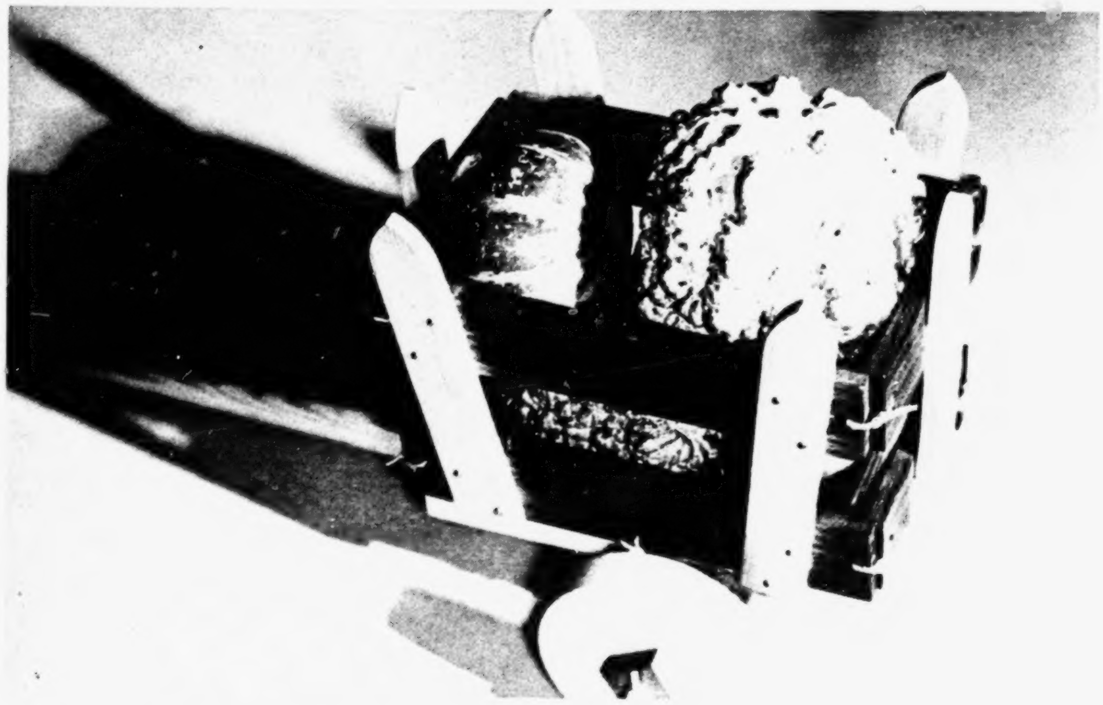
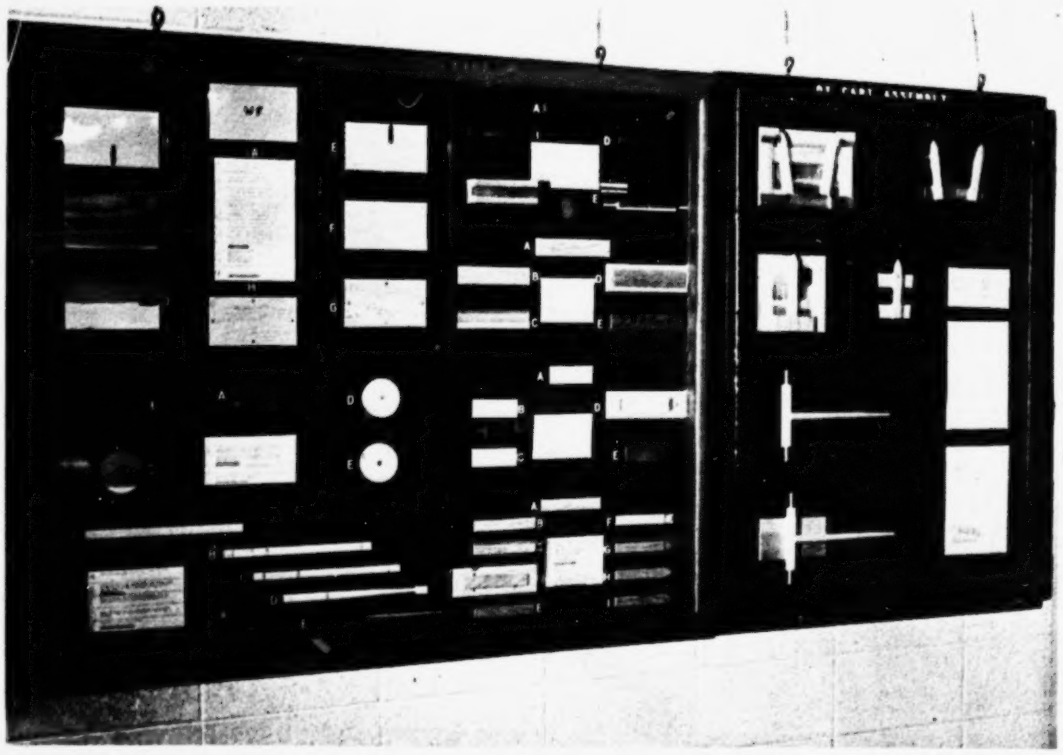
GENERAL SHOP


Mack Hoover

THE GENERAL SHOP



INSTRUCTIONAL AIDS AND ORGANIZATION ARE THE KEY TO TEACHING A SUCCESSFUL GENERAL SHOP.



CHAPTER IX

THE GENERAL SHOP

The general shop is closely related to the function of the junior high school. Throughout the history of the junior high school movement to the present, major emphasis has been on exploration and guidance, and providing for individual differences. The general shop fulfills these concepts by stressing exploratory activities in a diversified program. It enriches the junior high curriculum with its varied program and assists the student in making a smooth transition from elementary to senior high school. Special attention is given to helping students discover their aptitudes and interests. Hand and basic machine tool operations are stressed through the construction of functional projects. An understanding of industry is developed through the use and care of supplies, tools, and equipment, safety practices, related information and use of line-type, pupil-personnel organizational charts.

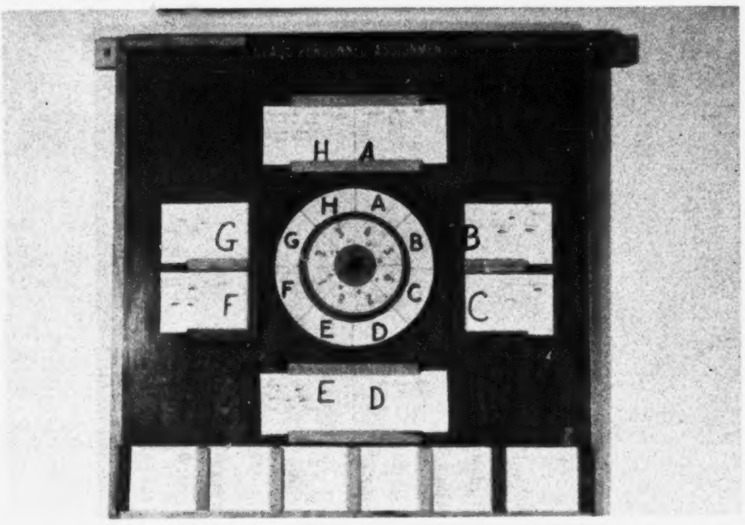
It is recommended that teachers who are able to take part in the planning of junior high general shops consider at least nine weeks in each of the various areas of industry. Broad areas included in this guide are: mechanical drawing, power mechanics, graphic arts, metalworking, electricity-electronics, woodworking and crafts. Nine weeks in each area would provide 1½ years of exploratory experience. It is generally acceptable for all seventh and eighth grade boys and girls to take general shop. Semester courses in these areas on an elective basis should be provided in the ninth grade.

In smaller schools, it may be necessary to plan shops for rotation in the various areas on a six weeks basis to give students the exploratory experiences. In this case, three areas of work taught in one shop could be taken in the seventh grade while the other three would be taken in the eighth grade. The smaller the school system, the greater the number of activities that may be taught in each shop. The junior high general shop should be closely related to the senior high industrial arts program.

At the senior high school level, unit shops should be available for students at least one year following their basic hand and machine tool operations. This higher level of training should encompass new materials and processes of modern industry. By its very nature, these courses should be taught in the unit shop rather than in the general shop.

The instructional material taught in a general shop is similar to the "basics" of material taught in a unit shop. The unit shop naturally covers the material in much greater depth. **The instructor may choose the material he wishes for his comprehensive general shop from the unit shop courses presented in this guide.** Material suitable to the general shop are indicated by astericks in the sections containing the subject content of the various areas. Craft material may be used in total for the general shop.

The general shop must be well organized to function smoothly. This type of shop requires a high degree of planning and therefore requires a well-qualified high



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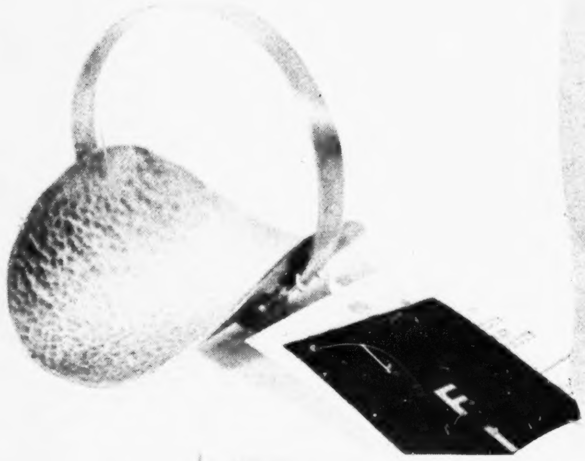
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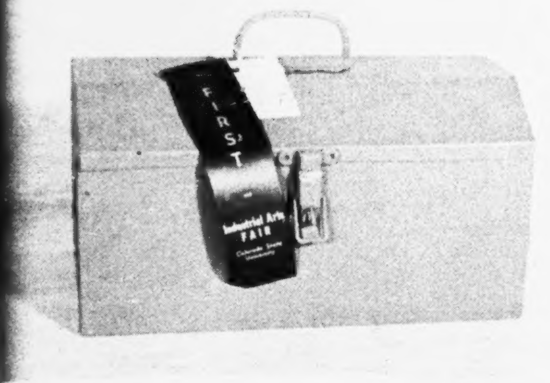
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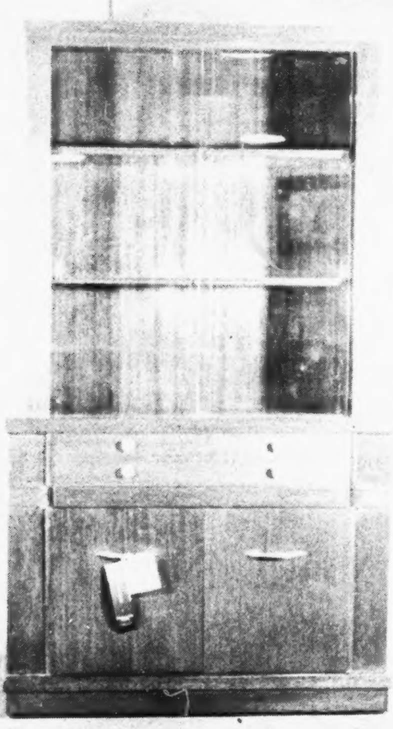

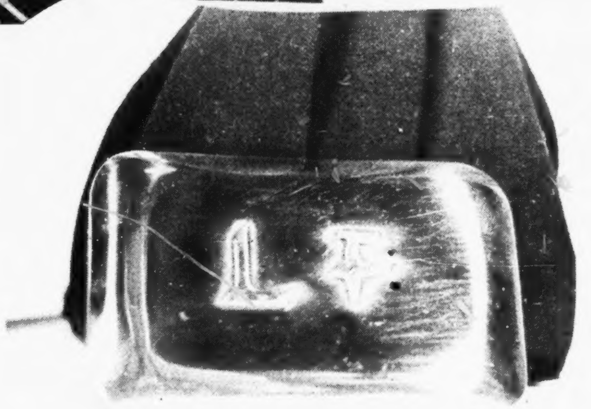

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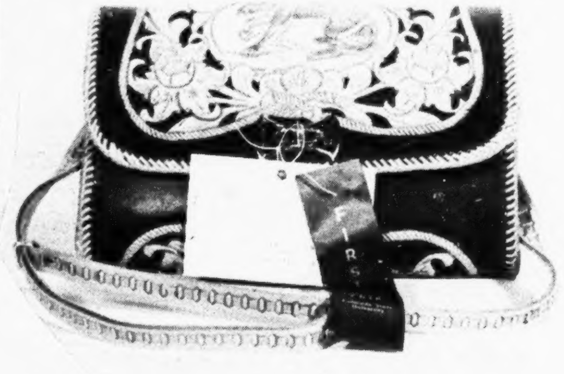
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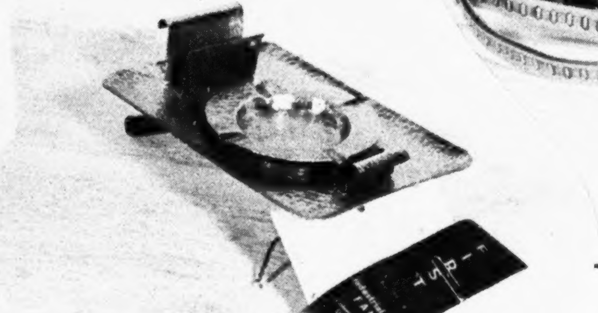
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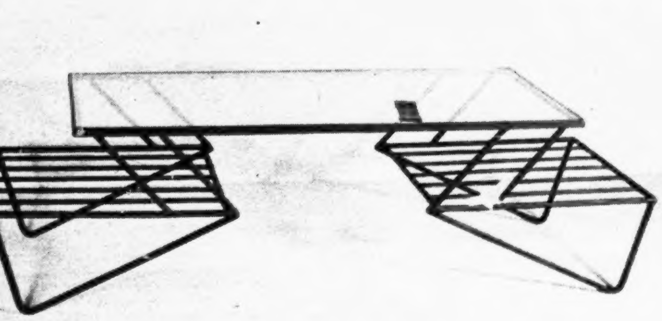
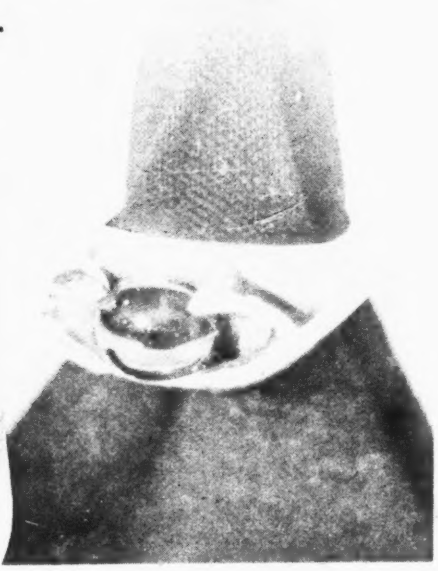
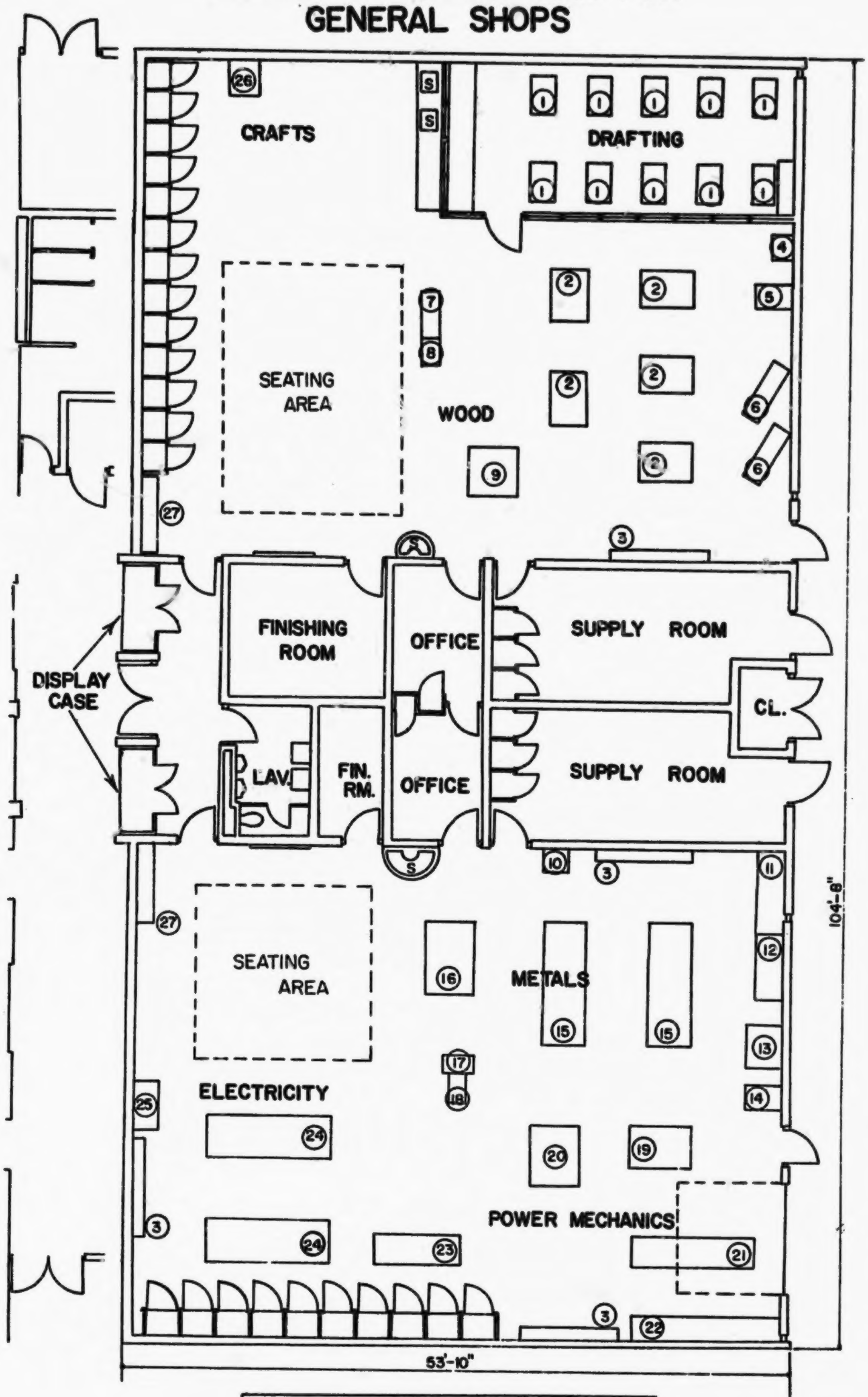




SUGGESTED FLOOR PLAN FOR GENERAL SHOPS


CRAFTS
DRAFTING
S
SEATING AREA
WOOD
FINISHING ROOM
OFFICE
SUPPLY ROOM
CL.
DISPLAY CASE
LAV.
FIN. RM.
OFFICE
SUPPLY ROOM
SEATING AREA
METALS
ELECTRICITY
POWER MECHANICS
104'-8"
53'-10"

EQUIPMENT INDEX

①	DRAFTING TABLE
②	WORK BENCH
③	TOOL STORAGE PANEL
④	GRINDER
⑤	BAND SAW
⑥	LATHE
⑦	JIG SAW
⑧	DRILL PRESS
⑨	POWER SAW
⑩	BUFFER
⑪	SHEET METAL BREAK
⑫	SLIP ROLL
⑬	LATHE
⑭	SHAPER
⑮	METAL BENCH
⑯	SQUARING SHEARS
⑰	GRINDER
⑱	DRILL
⑲	STAKE BENCH
⑳	SOLDER BENCH
㉑	POWER MECHANICS BENCH
㉒	BENCH
㉓	ELECTRICAL BENCH
㉔	ELECTRICAL BENCH
㉕	ELECTRICAL SOLDER BENCH
㉖	KILN
㉗	COAT & BOOK RACK

caliber teacher. Instruction sheets of all types should be utilized to aid the instructional process. Pupil-personnel charts, scale drawings or mock-ups of beginning projects and other teaching aids should be prepared beforehand.

It is suggested that a study of the book "Teaching Multiple Activities In Industrial Education," by Silvius and Curry be made in preparation to teaching the general shop. Topic 7, p. 83, should especially be studied. Following are some of the headings: "Areas for Activities", "Designating Work Stations", "Numbering Work Stations", "Getting the Class Started at the Beginning of the Term".[1]

Looking to the future, the industrial arts teacher should be alert to new ideas which will make his instruction meaningful to our society. It *is* possible to correlate industrial arts to science, mathematics, art, language arts and other subjects for the purpose of improving industrial arts. It *is* posible to teach mass production in a general shop as a means to help interpret industry. As an example, a study by the class could be made of a functional combination-materials project that would utilize all of the areas taught in a particular multiple-activity shop. Instead of being too concerned with rotation following a given amount of time, students would work at only several stations making duplicate parts. Observing the class structure would give them a keen insight into the actual workings of industry.

Power mechanics should be considered as one of the areas of work in the general shop at the junior high school level. For students who want to pursue this course further, unit courses should be available at the senior high school level. It is because of the impact that power has on our civilization that it is included in this guide. Information about the history of power and its importance to our way of life is presented to the students through various means such as reference books, films, and cut-outs of different power units which can be manipulated by students to learn and understand operating principles.

Teachers should be encouraged to experiment with new ideas and it is hoped that school boards will provide monies for experimentation and research to industrial arts teachers. If time were provided during the summer months, more Industrial Arts teachers would be encouraged to work closer with industry in determining what should be taught to best interpret industry. Industry must be encouraged to take a closer look at Industrial Arts.

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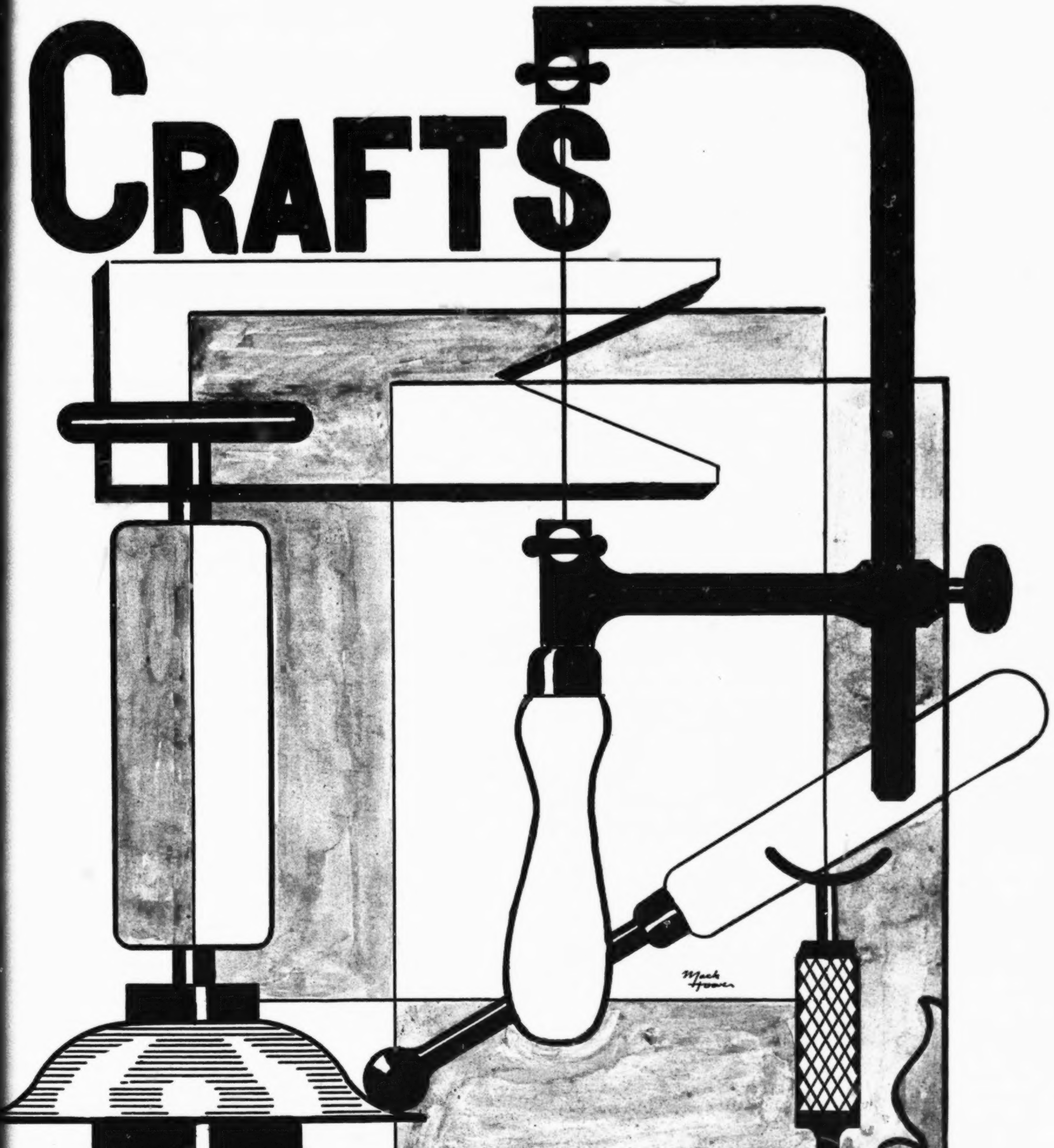

CRAFTS
Mack Hoover

CHAPTER X

GENERAL CRAFTS

Craft classes are held in the several general levels of the public schools; elementary, junior high and senior high schools. The varied areas of crafts provide desirable activities in industrial arts. They are highly interesting to the students, provide for creative activity, development of avocational interests, and give the student an opportunity to study many industrial materials and products. The nature of the subject matter in crafts makes it appropriate for beginners, regardless of grade level, to begin with less difficult projects and advance according to individual abilities.

The areas of study as listed in this guide are normally included in a general shop type course, usually taught at junior high level, and are taught simultaneously to small groups or individuals within the class. Another common approach is to have the entire student group pursuing a specific area for a length of time and then progressing through other areas of work as might be chosen by the teacher and the students. However, required or elective area offerings vary with the over-all program as organized in each school, and with the type of physical plants available. There are a number of factors (physical plant, tools, equipment, qualifications of the instructor, etc.) to determine the areas to be offered in general crafts. However, approximately six to nine weeks should be spent in each of the chosen areas.

The crafts areas discussed in this guide are not to be considered complete. Selections from other areas in the guide are quite often taught in craft shops and prove to be very satisfactory. For other suggested areas of study, check wood carving, art metal, linoleum block printing, textiles, camp crafts, and others.

There are no real prerequisites for courses in crafts, although previous drawing and shop practices are helpful in the secondary schools.

The specific objectives of crafts courses could be listed as avocational interests and consumer education through knowledge gained regarding the manufacturing processes and practices, and through selection of well-made consumer goods together with the recognition of quality workmanship and materials. Many reference books should be available in the shop library for project selection and study, rather than using specific textbooks for the areas of study in general crafts. References are listed at the end of the crafts area as an aid to the teacher in building a shop library.

CERAMICS

Ceramics and pottery are products made from clay. Everyone uses ceramic products in many different forms, such as dishes, toys, building tile, brick, bathroom fixtures, and many others. The making of clay products is a large and growing industry in the world today, and therefore is an important part of our industrial arts program.

Hardly any material in nature offers a broader opportunity to study than clay, and few substances affect our daily life more closely. Clay is the only material in nature which can be molded or changed in shape without breaking up, or destroying its continuity as a whole, and still retain a new shape or form.

A course in basic ceramics should include an understanding of the ceramics industry, and job opportunities. An appreciation of good design, workmanship, and finish on any ceramic product should be emphasized. Students should have the opportunity to model small figures and objects with their hands and modeling tools. Knowledge should be obtained in the slab and coil method, slip casting, and firing and glazing of ceramic projects.

Working with clay helps a student to recognize well designed and quality products on the market today. Sometimes the study of ceramics can develop into a worthwhile hobby, or leisuretime activity.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	*Types and properties of clay	Their uses	**Reference Books 15,27
Planning the project	*Design of clay projects	Characteristics of clay	Books 22, 41
Conditioning of clay	*Methods of preparing clay	Reasons for edging and preparing clay	Books 22, 27 Film 114
Simple modeling of clay projects	*Free form projects	Tools or instruments used	Book 22
Coil building method	*Layout procedures	Advantages and uses of coil method	Books 27, 35 Film 105
Slab building method	*Layout procedures	Advantages and use of slab method	Books 15, 48 Film 94, 109
Slip casting	*Use of plaster of paris molds	How molds are made, and different types of molds	Books 41, 48 Film 105
Decorating processes	*Methods of applying decoration	Reasons for decorating ceramic projects	Book 48 Film 105
Glazing	*Preparation and the application of glaze 4 methods used	Types of glazes Care and handling of glazed pieces	Books 22, 27 Films 91, 93, 101
Firing	*Ways of stacking kiln for different firings	Types of kilns, their uses and advantages	Books 27, 50 Films 92, 110

* Identifies areas applicable to general shop.

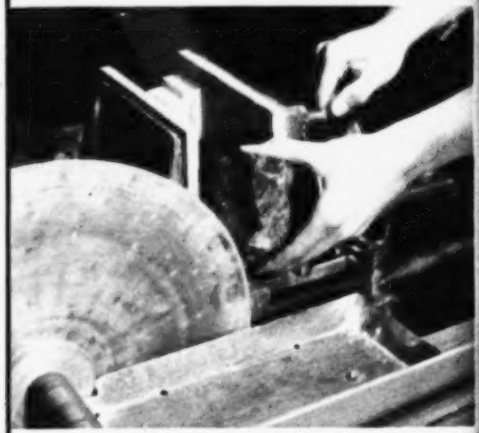
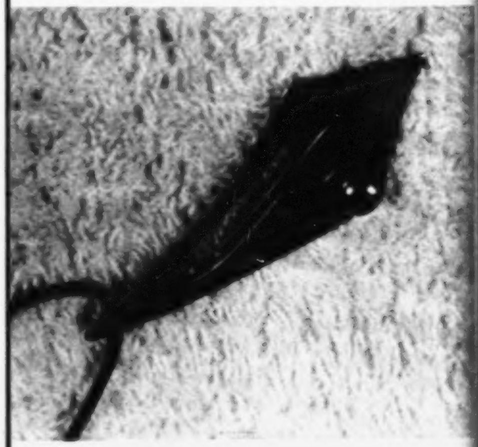
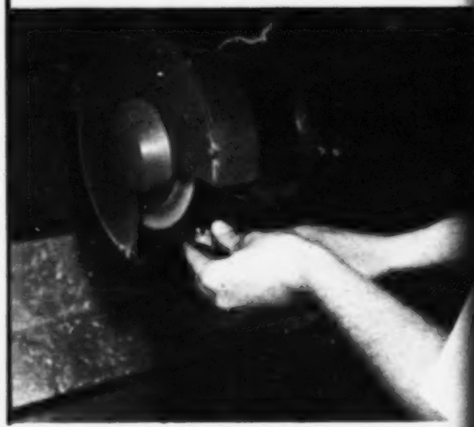
**Check reference numbers at end of unit.

Projects — Ceramics

Animals
Automobiles
Projects of imagination
Candle stick holders
Heads
Ash trays
Bowls
Salt and pepper shakers
Mugs
Vases

LAPIDARY

During recent decades, the collecting of minerals and the subsequent fashioning and mounting of them as gems have become fascinating hobbies for thousands of nature lovers. The area of lapidary enables the student to learn more about our natural world of the earth and rocks beneath our feet. It is an applied approach to geology. The student also learns many of the industrial techniques in the shaping and forming of these stones that have lapidary value. The student also acquires skills in working with metal and an appreciation of work well done while fabricating the mountings for the polished stones.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Sawing with diamond saw a. Slabbing b. Trimming	*Coolant to be used Orientation of stone Safety in operation of diamond saw	Industrial uses for diamonds Types of blades and sawing machines	**Book 2 
Marking with template and aluminum pencil Free form designing	*Design	Why templates are used Material used for marking stone	Books 20, 59 
Grinding to outline with beveled edge	*Degree of bevel Water coolant Safety in operation of grinders	Physical characteristics of grinding wheels Grit sizes	Book 49 

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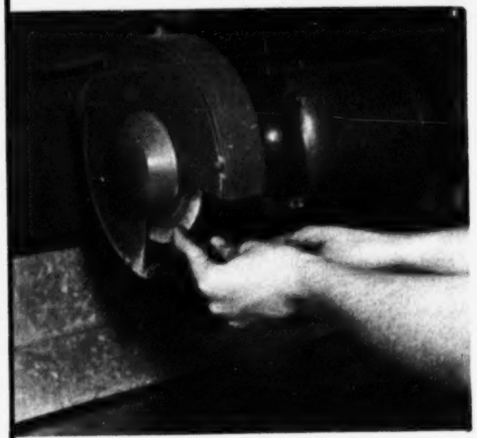
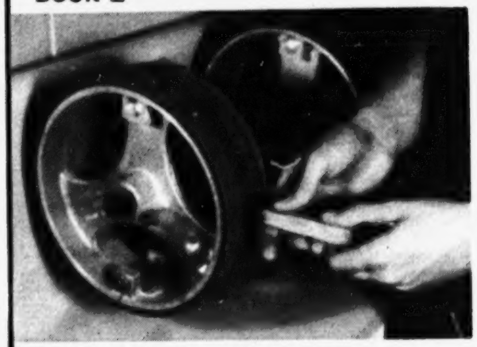
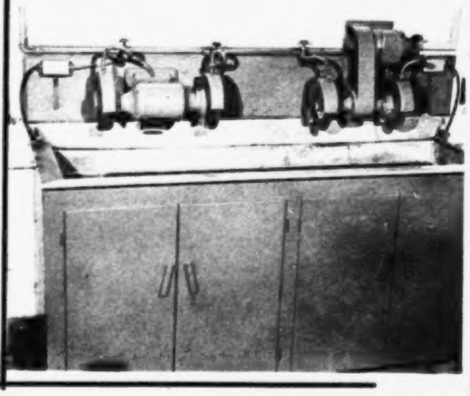
*Identifies areas applicable to general shop.

**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Dopping stone	*Temperature control Dopping waxes Stones that are heat sensitive	Composition of dopping wax	Book 2
Grinding crown	*Crown of cabachon (should be an arc or circle)	Meaning of cabachon How silicon carbide is made	Book 2 
Sanding a. Wet sanding b. Dry sanding	*Safety in operation of sander Advantages of each type of sander Kind and size of abrasives How to tell when sanding is complete	Types of machines Abrasives a. Natural b. Man-made Common industrial uses	Book 2 
Polishing	*Polishing agents Polishing wheel a. Material b. Speed	Types of polishing equipment Hardness of gem stone	Book 6

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Advanced processes a. Drilling of stone	Operation of a gem drill	Abrasives a. Diamond bort b. Boron carbide	Book 2
b. Lapping	*Operation of cast iron flat lap unit	Abrasives a. Grit sizes b. Silicon carbide	Book 2
c. Sphere cutting	Operation of a sphere cutting machine Sawing in preparation for cutting sphere	Same as above Process of polishing	Books 49, 54
d. Faceting	Operation of a faceting head Operation of flat lap a. Diamond impregnated b. Tin polishing laps c. Lucite polishing lap d. Dopping		Book 53
e. Tumbling	*Operation of a tumbler. Grits and grit sizes. Comparative hardness of stones	Geologic formation of stones	Book 43
f. Carving	Operation of beginning and advanced lapidary equipment	Suitable stones for carving	Book 54 

* Identifies areas applicable to general shop.

Projects — Lapidary:

1. Paper weight
2. Desk pen base
3. Cabachons to be used for:

a. Ring stones
b. Pendant
c. Earrings
d. Cufflinks
e. Tie bar
g. Brooch
f. Belt buckle
h. Bracelet
i. Bola tie
j. Buttons

LEATHER

Leatherwork has become a successful industrial arts area. It is an excellent transitional activity between the elementary school with its arts and crafts and industrial arts at the secondary level. The student is able to learn fundamental safety rules and shop organization of industrial arts without being exposed to the dangers of machines.

While the employment opportunities for hand leather workers are limited, there are numerous industries which process leather into machine-made goods in large quantities. These include the shoe, garment, and personal accessory industries, as well as sporting goods industries and others.

The leisure-time applications of leatherworking are almost without limit. Leatherworking skills can be used to produce gifts as well as to produce useful items for the craftsman himself.

The teacher with little training and experience in leatherworking can start a course in junior high school on a small budget, then enlarge the program as his skill and confidence grow. Few materials can be worked so well at so many different levels of skill.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Making patterns a. Cutting leather b. Surface design	*Use of tin snips Lay out drawing Tracing techniques Reading a rule	Theory of design Uses or application of leather	**Book 8
Cutting leather	*Use of leather shears Use of X-Acto knife Use of round knife Use of draw gauge Use of square	Techniques used by saddle makers Uses of leather	Chart 63
Wetting leather	*Uniform sponging (avoid water spotting) Casing (avoid mildew)	Making leather Types of tannage	Films 111, 112
Establishing edge and the border of leather		History	Book 8
Transferring design	*Use of tracer Use of stylus Use of modeling tool Use of pencil Thumb tack pattern Tape pattern	Artifacts	Book 8
Tooling processes	*Outline tooling Flat modeling Stippling Beveling Repouse		Chart 66 Booklet 71

* Identifies areas applicable to general shop.

**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Stamping	*Border stamping Set stamping for large areas		Film 88
Carving	*Use of swivel cutter Bevel stamping Interior stamping a. Camouflage b. Shaders c. Bevelers d. Stops e. Veiners f. Seeders g. Background h. Decorative cuts		Pamphlets 67, 68, 69, 70, 72, 76, 77, 78, 79, 80 Films 89, 90, 107
Coloring leather	Antique dye Liquid dye Colored inks	How dye is made	Pamphlet 74
Skiving	*Edge skiving Skiving lace		Book 8
Cementing	*Linings Project assembling	Types of cement and glues	Pamphlet 73
Punching	*Use of round drive punch Use of rotary spring punch Use of thonging chisel Use of bag punch Use of strap end punch	Dry leather Damp leather End grain punching or thonging block	Book 8
Sewing	Use of automatic sewing awl Harness needle Sewing machine		Pamphlet 82
Lacing	Spiral or whip stitch Cross whip stitch *Single cordovan Double cordovan Florentine	Making lacing needle from tin can metal	Pamphlet 84 Chart 64

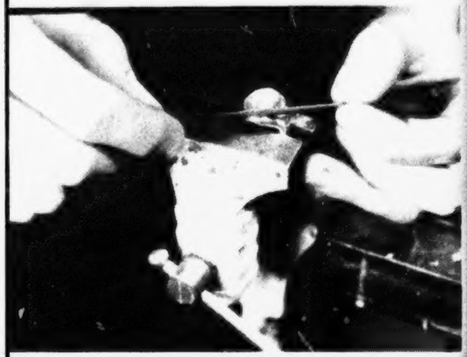
Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Splicing lace	*Skiving and cementing Tuck and lace		Book 8
Cleaning	*Oxalic acid Saddle soap	Types and composition of cleaners for leather	Book 8
Finish	*Wax Neatsfoot Oil Treeing compound Neat-Lac	Techniques for refinishing old leather Tannery finishing methods	Book 8
Attaching hardware	*Snap fasteners Eyelets Bag clasps Buckles Rivets		Book 8
Braiding and weaving	4-plait square 4-plait octagonal 4-plait round diamond 4-plait round spiral Turks head Block braid	Romance of rawhide	Books 24, 25 Pamphlet 75

Projects — Leathercraft:

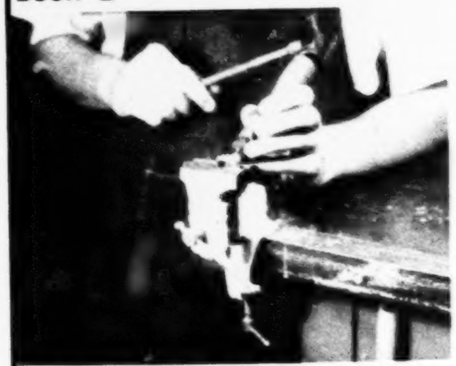
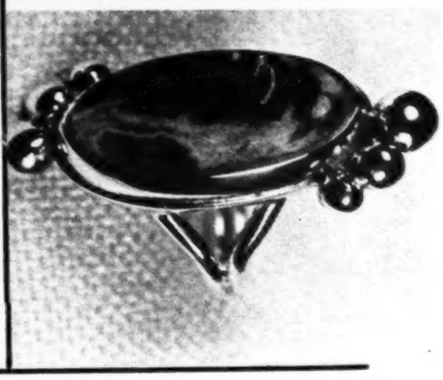
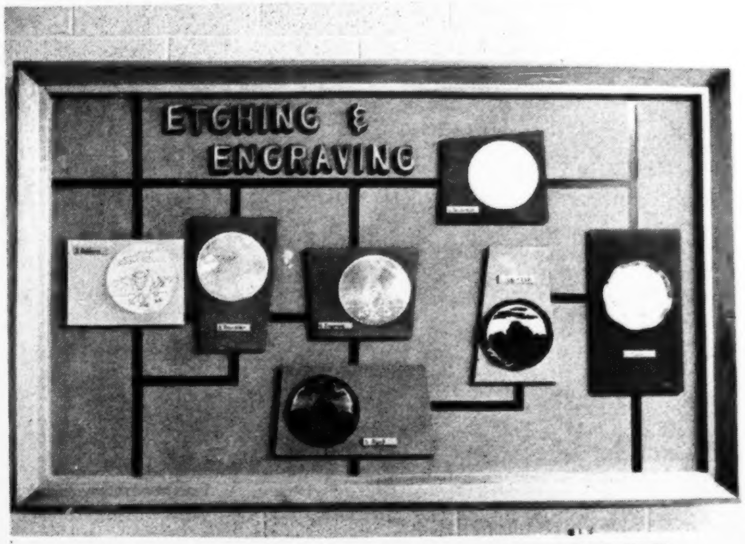
Triangle coin purse
One post key case
Bookmark
Small coin purse
Comb case
Two post key case
Baggage tag
Coin purse (one flap, 2 compartment)
Triangle two flap coin purse
Snap comb case
Comb and file case
Two flap coin purse
Four hook key case
Identification card case
Two flap accordion coin purse
Pull ring key case
Six hook key case
Knife sheath
Axe sheath
Combination coin purse and key case
Double photograph holder
Standard size cigarette case
King size cigarette case
Ladies billfold
Men's billfold
One-piece accordion coin purse
Tooled belt
Stamped belt
Carved belt
Check fold and card case

METAL JEWELRY

Metal jewelry may be offered as an area of general crafts or as an area in general bench metal work. This area enables the student to use a creative approach to jewelry as an art expression, and encourages the student to utilize the short stock of the non-ferrous materials of the metal shop. It also enables the student to acquire some skills in some of the industrial processes of the metals field. An appreciation of a job well done is easily taught through the personal items completed in the metal jewelry area.

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Planning and layout of project	*Design and structure of different articles of jewelry Kinds of metals Gauges of metals Metal properties	Functional design	
Make bill of materials			
Cutting of material a. Using tinner's snips b. Using jeweler's saw	*Correct use of snips Operational technique in the use of jeweler's saw	Industrial methods	
Drilling of material a. Hand drill b. Drill press	*Safety in use of drill press Operation of hand drill Operation of flex Shaft drill	How to sharpen a drill bit	
Shaping and smoothing of material a. Filing b. Sanding		Cleaning and care of files Abrasives Correct use of a jeweler's vise	
Soldering a. Cleaning b. Fluxing c. Temperature control d. Use of pickle	*Methods of cleaning Purposes of fluxes Methods and safety in the use of pickle	Physical properties of solders	

*Identifies areas applicable to general shop.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Assembly a. Wiring b. Clamping			
Buffing and polishing of metals	*Safety in the use of a buffer	Industrial jewelry making Abrasives and polishing materials	**Book 6
Stone setting	*Refer to lapidary unit		Book 2  
Etching			
Engraving			
Casting a. Sand molds b. Investment c. Lost wax	Preparation of molds		Book 2

**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Enameling a. Kiln b. Torch	*Operation of kiln Firing temperature	Techniques in enameling	Book 44
Chasing			
Repousse			
Coloring			

Projects — Metal Jewelry:

Silver band ring
Silver brooch
Necklace swing
Earrings
Cuff links

Tie clip
Ring with stone
Bracelet with stone
Free form jewelry

MOSAICS

These wonderful, colorful pictures that capture the imagination of all are becoming more popular every day. Mosaics may have started when some of our ancestors, clothed in animal skins, found colorful pebbles along some stream and arranged them by sticking them into a clay bank along the stream. Who can say how they started, since archeologists have found mosaics at least 5,000 years old.

It is strange that there is no relationship between the materials used and the term "mosaics". When you speak of oil painting you know the medium used is oil mixed with ground minerals (color pigments). The same thing applies to water colors. They are minerals that can be mixed with water. In mosaics the different mediums or materials used can be counted in the thousands. A few of the materials are metal, stones, shells, ceramic tile, glass tile, Byzantine tile, felt, seeds, and countless others. The term mosaic generally refers to many pieces put together to form a design. The main fraction. The main qualities of mosaics are color, texture and light refraction. These materials form a perfect media for design, originality, art expression and are also used in industry.

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Plan project	*Design pertaining to mosaics	Different tiles and materials—source of materials Principles of design abstract, realistic, etc.	**Books 1, 29, 34, 61 Films 102, 115
Figure cost Making out project sheet	*Cost of various tiles and materials Size of various tiles and materials Composition of these materials	Price sheets Simple mathematics Methods of measurement	
Check-out of materials	*Conservation of materials	Check-out procedures	
Layout procedure	*Use of layout tools	Marking and measuring methods	
Construction of foundation for mosaic	*Cutting, forming, surfacing, and assembling of base materials	Reference to original drawing and plan of procedure	Films 102, 115
Layout of mosaic pattern	*Techniques of design layout	Reference to original drawing and plan of procedure	Book 1
Application of mosaic tile	*Technique of cutting, shaping, and cementing the tiles	Composition of cements and the methods and applications of mosaics in industry	Books 1, 29, 34, 61

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Application of border design	*Methods of complementing the whole project	Elements and principles of design	Book 1 Films 102, 115
Grouting	*Color combination, mixture and texture	Source of materials	Book 1
Cleaning and polishing of the tiles	*Materials used in cleaning and polishing	Future care and maintenance	Book 1

Projects — Mosaics:

Wall plaque
Table top
Trays
Trivets

Table lamp
Book ends
Drawer pulls
Desk sets

House number
Jewelry box
Planter box
Holiday themes

Hot plate
Patio pieces
Coasters
Candle holders

PLASTICS

The area of plastics may be added to the curriculum with a minimum of added expense for equipment because the regular wood and metal working tools and equipment may be used. With the increase in the development of the varied plastics, it is becoming one of the leading industrial materials. Many skills, techniques, and appreciation for craftsmanship may be developed in working with plastics and related materials.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Plan project	*Design for plastics	Types of plastics, cloth flexible containers, sheet film cast, paint, etc.	**Films 97, 98, 99, 100, 103, 106, 107
Making bill of materials	*Cost of materials, i.e., thickness, color, sheet rod tubing, extruded shapes	Manufacturing data extrusion, casting, laminating, etc.	Film 113
Layout of material	*Marking methods on plastic—pencil, scriber, compass, etc.	Layout procedures	Film 96
Sawing, hand	*Coping, hacksaw, and hand wood saws	Proper use of blade, number of teeth per inch, etc.	Film 96
Sawing with power equipment	*Safety procedures Special teeth on circular, band and jig saw blades	Mehods of setting blade, number of teeth, surface feet per min. operation, skip tooth blades, etc.	Film 96
Drilling	*Safety procedures Use of coolants	Specially ground drills	Film 96
Sanding—power and hand	*Safety procedures Procedures in sanding wet or dry	Types of abrasives Types of backings	Film 94
Polishing—power & hand	*Safety practices Proper procedures	Abrasives, buffing wheels, polishes, anti-static waxes	Film 96
Cementing	*Soak, dip, capillary, laminating clear cements, colored cements	Types of cements Adding color	Film 104

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Heat forming	*Blow and draw forming, straight line bending, hand held jigs, temperatures	Thermosetting and thermoplastic materials. Uses of various types	Film 99
Surface decoration	Overlays, etching, engraving Handwork and machine	Industrial methods and uses	
Carving a. Surface b. Internal	Safety practices, using power equipment, flexshaft, hand held machine, router, drill press	Grinding drills, use of burrs and other cutters	
Casting	Types of materials, mixing and procedures, embedding and use of color	Catalytic action of components	Film 100
Dyeing and coloring	Procedures	Types of dyes	

Projects — Plastics:

Desk items:
  Pen sets
  Stamp boxes
  Trays
  Letter holders
  Letter openers

Bedroom items:
  Powder boxes
  Vanity sets
  Pin boxes
  Trays
  Jewelry boxes
  Earring hangers
  Night lights
  Lamps

Bathroom items:
  Towel bars
  Towel rings
  Toothbrush holders
  Tumbler holders
  Soap dishes

Kitchen items:
  Towel bars
  Towel rings
  Soap holders
  Detergent dispensers
  Scoops
  Salt and pepper shakers
  Serving dishes
  Serving trays
  Canape servers
  Wall shelves

Other parts of the house:
  House numbers
  Mail box
  Candle holders
  Lamps:
    Reading
    Bed
    Pin-up
    Television
    Night lights

  Ornamental trays and dishes
  Small tables
  Wall shelves

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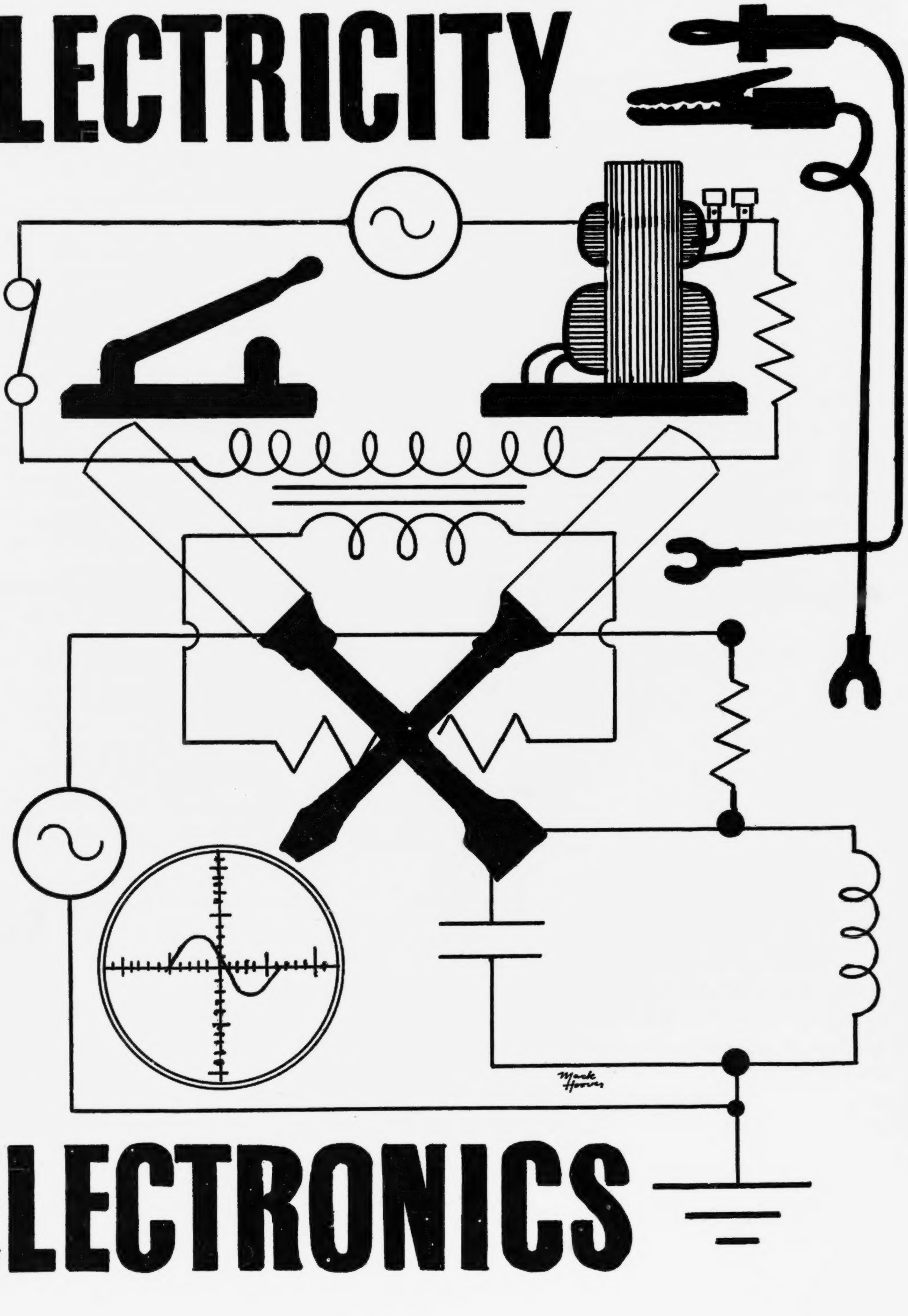
ELECTRICITY


Mack Hoover

ELECTRONICS

CHAPTER XI

BASIC ELECTRICITY AND ELECTRONICS

We are now living in the "Age of Electricity and Electronics". Anyone who wishes to feel at home in the world of modern technology must be familiar with the fundamentals of electricity and electronics. We are constantly depending upon electricity and electronics that have added comfort and convenience to our daily lives. Many students may never operate some of the objects of nuclear science, but they need to know the basic principles of the electrical things that are commonly found in their homes today.

This course outline will be useful as a guide for a separate course sequence in electricity and electronics or as a guide to preparing units which can be included in a metals, wood, crafts, or other suitable laboratory setting. Every effort has been made to identify those topics of fundamental knowledge and experiences which might be covered in a sequential order. The fundamental topics of knowledge identified by asterisks are considered to be minimum requirements, and these areas would be applicable to the general shop. The purpose of identifying certain topics of knowledge is to indicate to the teacher the basic concepts which lead to an adequate understanding of the field of electricity and electronics.

Electricity-electronics can be taught in the junior or senior high school. Regardless of the level started, students should begin with the same or similar concepts and experiences. This will facilitate any transition brought on by the mobility factor of the school population. It is strongly recommended that the courses outlined be taught, wherever possible, during the entire school year. The division of time related to theory, demonstrations, and student activities is left to the judgment of the individual teacher. A sincere attempt should be made to include theory, demonstrations, project construction, and experiments. Project construction should be used to supplement a sound program of instruction rather than having projects determine course content.

Wherever "Fundamental Knowledge" items exist but no student operations are listed, it is to be understood that the student should be required to explain the concepts involved. The fundamental purpose of this course of study is to create an interest in the student and to develop an understanding of the area of electricity and electronics.

A third outline has been included in brief form to help those individuals whose time and equipment warrant further instruction. This third outline deals with general applications of electricity and electronics in the home and industry.

Equipment Recommendations:

Grades 10-11-12

The electricity-electronics laboratory should be as well equipped as possible. The following recommendations are considered minimum needs for a class of 24 students.

Basic Electricity

One each of the following:

1. Five-inch oscilloscope
2. Vacuum tube voltmeter
3. Volt ohm milliammeter
4. R.F. signal generator
5. Audio oscillator
6. Tube checker
7. Transistor — diode checker
8. Capacitor checker
9. D.C. power supply (portable)
10. Signal tracer

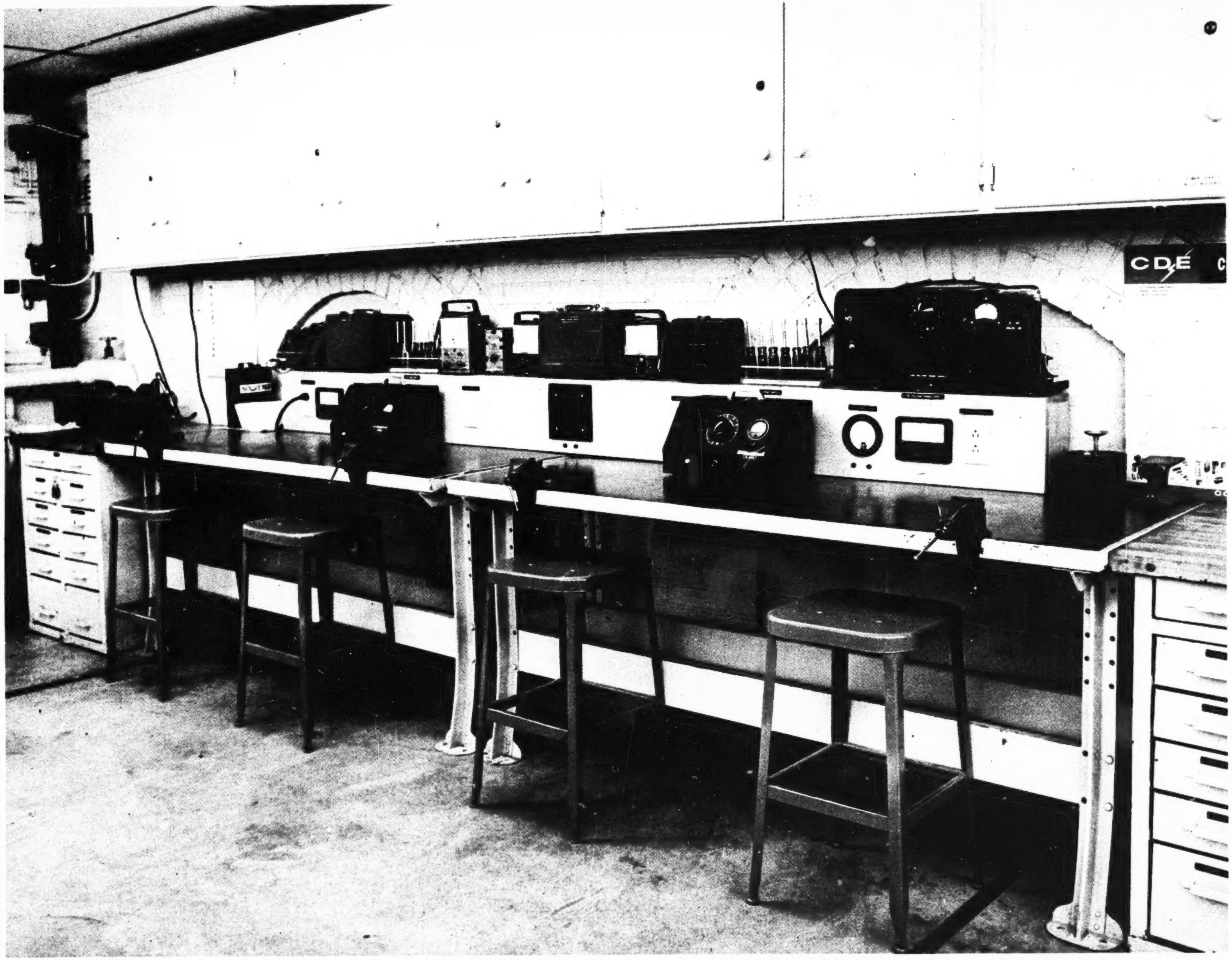
In addition, one vacuum tube voltmeter for each two students.

Basic Electronics

One each of the following for each four students is recommended, assuming that the above equipment is available to the electronics classes.

1. Five-inch oscilloscope
2. Audio oscillator
3. D.C. power supply (portable)
4. R.F. signal generator

STATION 4
STATION 2
EXIT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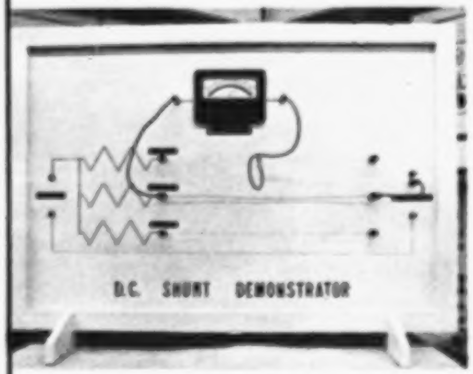
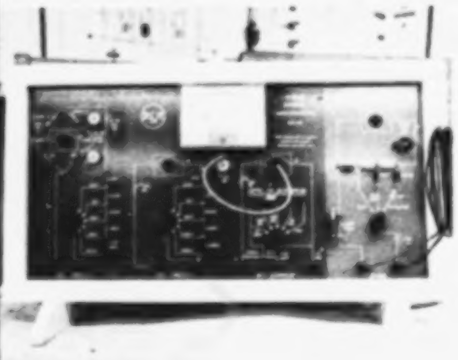
Basic Electricity

The study of electrostatics, electromagnetic, and electro-chemical effects of electron motion in components considered to be liquid or solid in nature which have resistance, capacitance and inductance, will be Basic Electricity. Placing a dividing line between "pure" electricity and "pure" electronics is rather difficult. For the separation in this course of study, those areas of instruction dealing with devices, circuits, or systems involving emission, behavior, and effect of electronics in gases, vacuums, crystals and semi-conductors will be covered in Electronics.

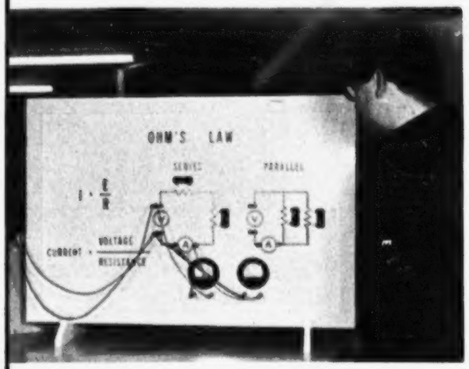
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	HISTORY, ELECTRON THEORY		
		Historical development of electricity	
Check shop voltages	*Safety in the electrical shop		
	Atomic structure of matter		
Charge and Discharge a capacitor with DC	*Law of electrical charges		
		Definition of electricity (dynamic and static)	**F.S. 127 Films 75, 19, 80, 83, 84, 85
	*Electron motion and current flow		Film 122
	*Electrical terminology		
	*Units of electrical measure and their symbols		Film 68
		Mathematical applications for electricity (sliderule)	
		Job opportunities in Electricity-Electronics	

* Identifies areas applicable to general shop.
** Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	MAGNETISM		
		History and background of magnetism	
Compare strength of several magnetic fields	Types of magnets (natural & articficial)	Theory of magnetism	Films 90, 92, 93, 94
Test materials with magnet to check induced magnetism	Magnetic properties of materials		
		Shapes of magnets	Collect metalic materials to show their magnetic qualities, if any
		Theory of magnetic measurement	
Experiment with electromagnetic device such as; sucking coil, relay, bell, buzzer, electric pencil	*Laws & theories of electromagnetism		
		Applications of electromagnetism	Read directions with compass and explain the need for corrections and geo. location
	PRODUCTION OF ELECTRICITY		
Assemble simple voltic cellor; rotate PM motor as generator, check output of solar cell, thermocouple, or crystal with galvanometer	Sources & methods of producing electrical energy (thermal, photoelectric, solar, mechanical, chemical, piezeoelectric)		Film 70 Battery kits are available for school use from battery manufacturers
	*Types of electrical curent (AC & DC)		
		Maintenance & limitations of electrical generators	Open & inspect an old car generator, explain its operation

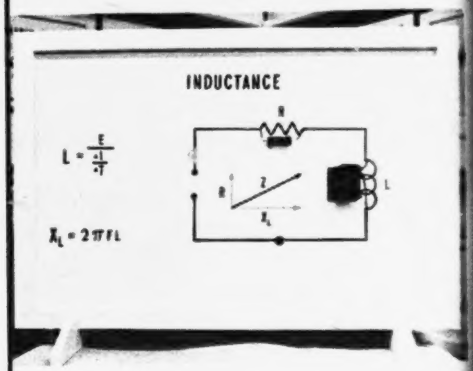
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
		Applications of electrical generators	F.S. 126
	MEASURING INSTRUMENTS		
		Theory, types & application of meter movements	Wall or notebook charts available on meter movements from manufacturers
		Purpose & methods of meter calibration	
Take meter readings	*Interpretation of meter scales & ranges		
Determine type of current in conductor (AC - DC)	Characteristics of commercial meters		Open and explore the internal structure of a meter (V.O.M. or V.T.U.M.)
Replace meter fuses; batteries	*Care & applications of measuring instruments		
Repair test leads			

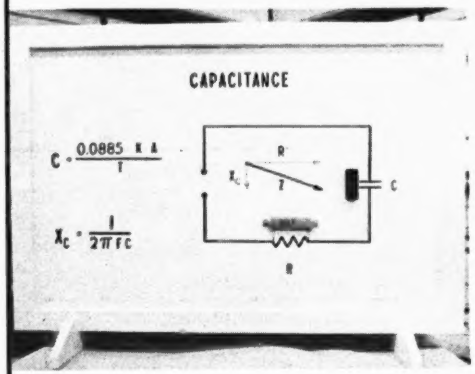
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	DC CIRCUITS		
Experiment with conductors of various materials in series with light bulb—note effects of resistance	Purpose, types & sizes of electrical conductors		
Layout series circuit	*Purpose & types of electrical insulators		Films 110, 112
Layout parallel circuit (use schematic symbols)	*Schematic diagram symbols & theory of circuit layout (series-parallel)		Films 100, 112
Set-up circuit & take voltage readings—calculate expected readings for same circuit & compare differences	*Ohm's Law for DC circuits		Films 95, 96, 101
	Kirchhoff's Law for DC circuits		Film 97
	Watt's Law for DC circuits		
Measure resistance with Ohm-meter	*Types, sizes & functions of fixed & variable resistances		
Determine resistor values from color code	*Purpose & functions of E.I.A. resistor color code		

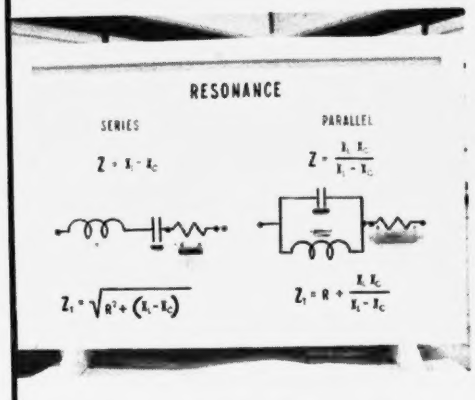
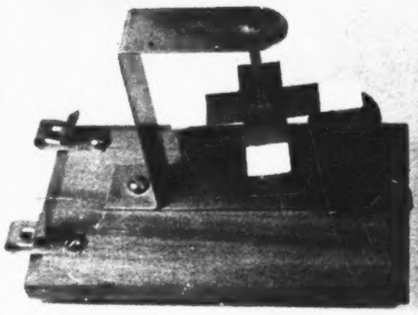
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Read color-code calculator		Applications of voltage divider networks	
Tin soldering tool	*Definitions & applications of mathematical prefixes (milli, micro, mega, kilo, nano, micro-micro)		Ohm's Law demonstration board set-up very helpful
Solder electrical connections	Types & sizes of electrical switches		 OHM'S LAW SERIES PARALLEL I = E/R CURRENT = VOLTAGE/RESISTANCE V A
Locate & price specific electrical components in an electrical suppliers catalog			
Connect 2-way & 3-way switches in circuit			
Draw & interpret schematic diagram of electrical device	*Functions of circuit diagrams (schematic & wiring)	Methods of communicating electrical ideas (words, symbols, pictures)	F.S. 125
Heat with electrical current	Effects of electrical current	Theory of varying or pulsating DC	Film 78
Light with electrical current			
Connect & energize electromagnet			

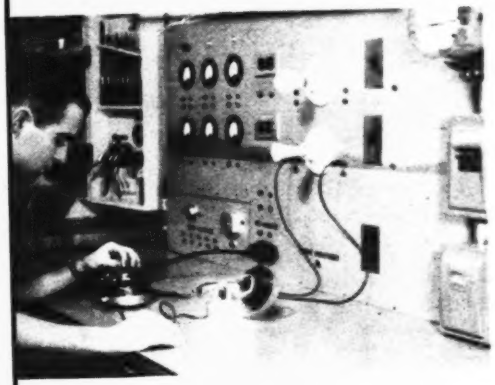
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Electroplate with electric current			
Connect cells in series & parallel & take voltage readings	*Theory & application of hooking cells in series, parallel, series-parallel		Films 100, 110, 111
Connect sockets, switches & plugs		Types of electrical energy (kinetic & potential)	
Tie Underwriters knot		Comparison of mechanical & electric power	
Measure electrical power (ExI & calculate, or use wattmeter)		Measurement of electrical power	Film 70
		Function & application of power networks (power factor)	
	SAFETY		
	*Safety rules for working with electrical devices		
Test & replace over-current protective devices	Sizes & types of circuit protection devices		Demonstrate fuse & circuit breaker
	Proper use of sockets, switches & extension cords		Field trip to local power line repair crew. Have them explain safety procedures they use
	*Proper grounding of electrical equipment		
	*Effects of current on human body		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	*First-aid for electrical shock		
	ALTERNATING CURRENT *Theory of AC generation		
	*Characteristics & functions of sine curve		Demonstrate A.C. wave forms on Oscilliscope (sine & square)
Measure RMS voltage with meter	Values of AC current & voltage (average, peak, RMS, effective)		Film 67
Measure current with meter			
Make graph of sine wave			
	Meaning of phase & phase angle		
		Explanation of frequency spectrum	Demonstrate and measure frequency of line current with frequency meter (if available)
	INDUCTANCE AND INDUCTORS *Characteristics & effects of inductance		Demonstrate effect of inductance on current flow
Construct soldering gun, transformer or some similar device		Measurement of inductance	
	Theory & application of inductive circuits		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Theory & application of Lenz's Law		
	*Theory of transformer operation		Film 115
		AC circuit calculations involving inductance	 INDUCTANCE $L = \frac{E}{\frac{\Delta I}{\Delta T}}$ $X_L = 2\pi FL$ R Z R X_L L
	Types, sizes & applications of coils & inductive devices		Film 91
	Factors affecting or controlling inductance		
	TRANSFORMERS		
Locate & list transformer specifications in supply catalog	*Characteristics, types, & uses of transformers		Tear down old low voltage X-former—locate taps and primary windings
		Impedance matching of power transformers	
	Theory of transformer construction		
		Interpretation of transformer color code (leads)	
		Transformer power losses	Inspect X-former core — observe laminate strips

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	CAPACITANCE AND CAPACITORS		
Charge & discharge capacitor in series with neon lamp	*Definition & theory of capacitors		Film 71
Cut open discarded capacitor	*Types & physical construction of capacitors (fixed & variable)		 CAPACITANCE C = 0.0885 K A / T X_C = 1 / 2π F C R X_C Z C R
Build capacitor checker		Theory of capacitive measurement	
	Causes & effects of capacitance	Interpretation of E.I.A. capacitor color code	Demonstrate effect of filter capacitors in a power supply using oscilloscope
	Circuit applications of capacitors		
	AC CIRCUIT ANALYSIS		
Hook-up L-C circuit		Theory of LRC series circuits	
Hook-up R-C circuit		Theory of LRC parallel circuits	
Hook-up L-R circuit			
Hook-up LRC circuit (Observe condition of resonance)		Vector addition of currents	

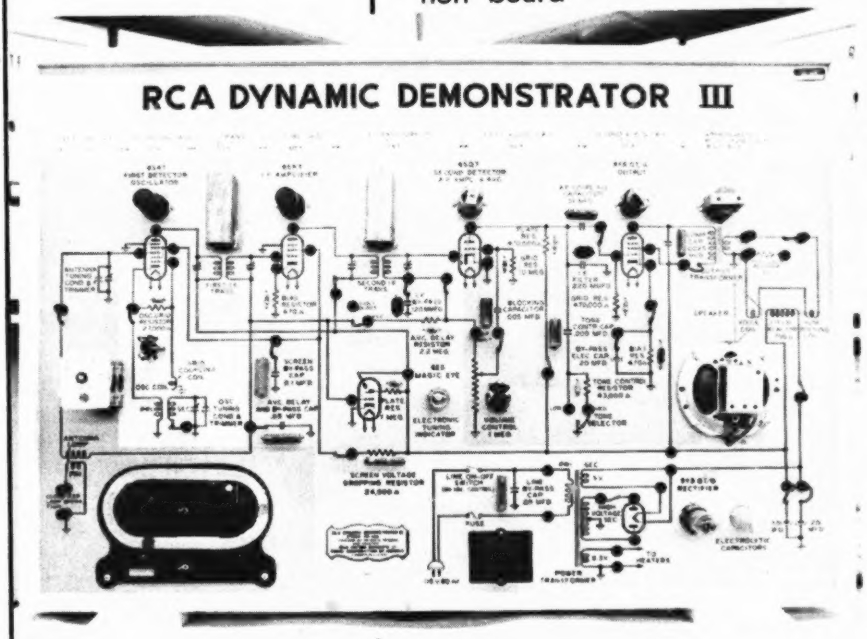
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Work problems involving impedance (Z)	Calculation of circuit impedance (Z)		 RESONANCE SERIES PARALLEL $Z = X_L - X_C$ $Z = \frac{X_L X_C}{X_L - X_C}$ $Z_T = \sqrt{R^2 + (X_L - X_C)}$ $Z_T = R + \frac{X_L X_C}{X_L - X_C}$
	Effect of frequency on AC circuits		
	Characteristics & applications of series-parallel resonant circuits		
	Functions & applications of filter circuits		
Construct diode, selenium or similar type power supply		Frequency measurement & wageform characteristics of RF	
	Methods of coupling AC circuits		
	MOTORS AND GENERATORS		
Connect & operate DC generator	Theory, operation, types & construction of DC generators		F.S. 126 Films 77, 89, 113
Operate small DC motor powered by DC generator	*Theory, operation, types & construction of DC motors		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Clean armature commutator on motor or generator		Purpose & need for DC motor control	Build mock-up or dynamic model of series DC motor
	Requirements of motor control & maintenance		
	Theory, operation, types, & construction of alternators		F.S. 126
		Need for frequency & voltage stabilization in alternators	
Reverse direction of AC or DC motor	*Theory, operation, types & construction of AC motors		F.S. 126
Connect a reohstat & vary speed of motor	Requirements of AC or DC motor protection & control		
		Methods of rewinding motors & generators	
		Procedure for figuring motor & generator efficiency	
	ELECTRIC WIRING AND ILLUMINATION		
	Purpose & function of National Board of Fire Underwriters		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Need & purpose of national electric code		National electric code available from city building inspectors office or local electrical contractor
		Selection & requirements of service entrance	
	Types & applications of switches & controls for housewiring	Theory of light production by current passing through low pressue gas	
Replace flourescent lamp, starter & ballast	Types & operation of gas discharge lamps		Tour house under construction with wiring exposed. Have electrician explain procedure followed in wiring the house
		Operation & application of arc lights	
Construct or repair lamp (household)		Electric power & polyphase systems	
	Adequate wiring requirements		
Repair common household appliance		Need, application & calculation or branch circuits	
	Theory & need for good lighting		

Basic Electronics

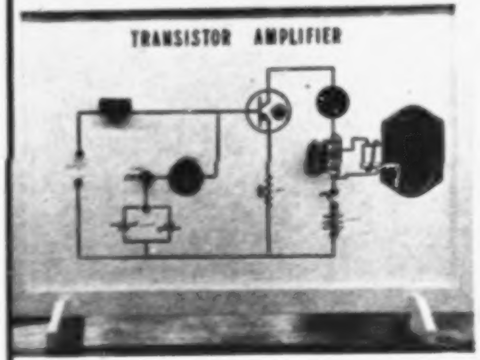
This course is designed as a sequence course for junior-senior high school students who have completed the course in basic electricity. This course should cover thirty-six weeks of instruction of technical and related information associated with electronic components, circuits and equipment.

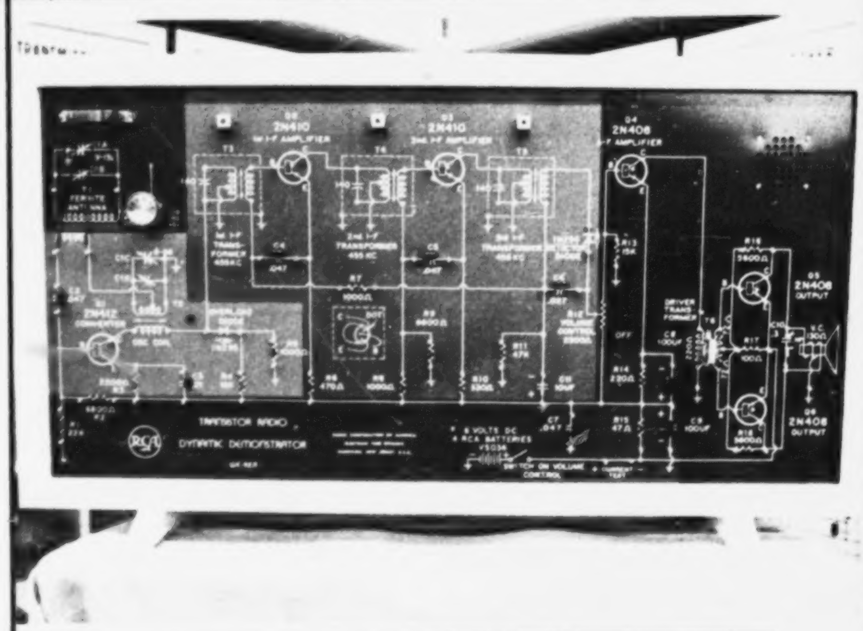
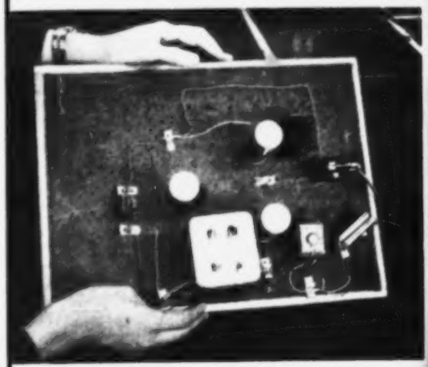
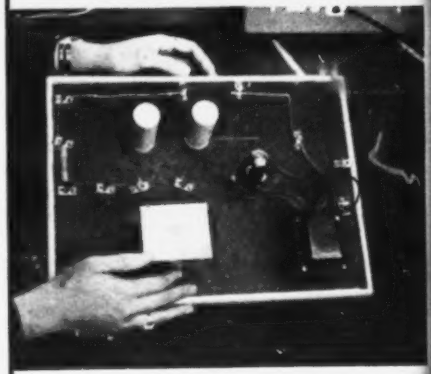
Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
	INTRODUCTION TO ELECTRONICS		
	Historical development of electronics		
	General applications of electronics		
		Basic transmitter & receiver operation	
Identify electronic symbols	*Types & purpose of electronic symbols		Point out parts in radio chassis or on demonstration board
	New electronic developments		
List precautions in handling electronic components	*Assembly techniques for electronic components		
	*Types & operation of electronic components		
Plan & layout etched circuit	History & methods of producing printed circuits	Job opportunities in electronics	

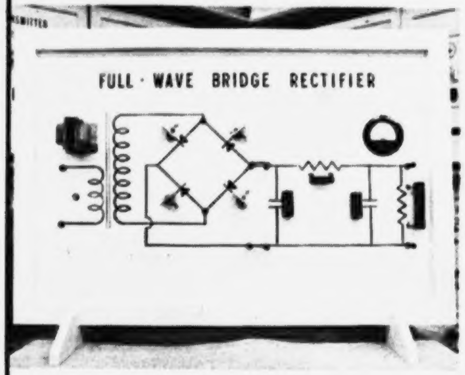
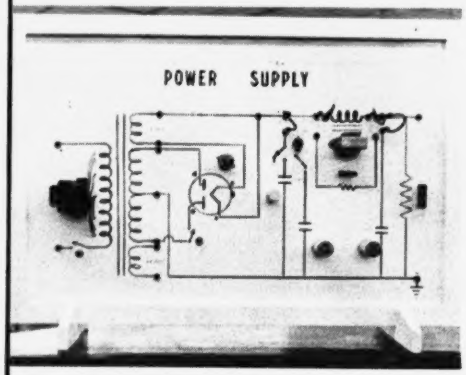
*Identifies areas applicable to general shop.

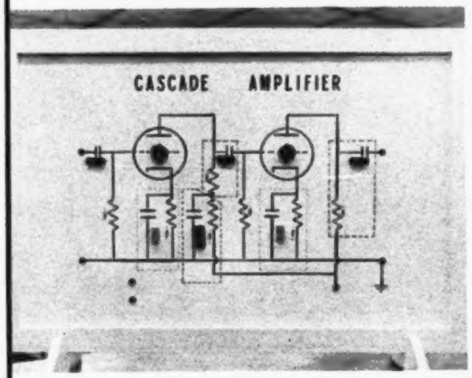
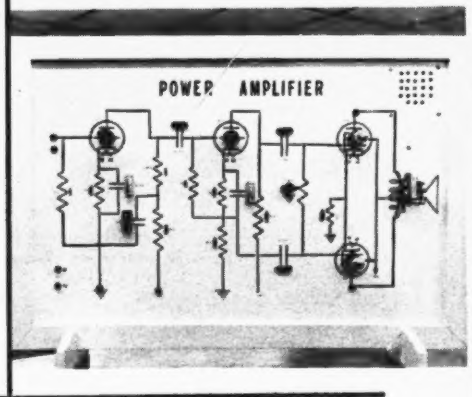
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Construct transistorized project on printed circuit	Planning & layout of etched circuit	Principles of chassis layout	
	Methods of mounting components on printed circuit board	Common materials for making printed circuits	
	ELECTRON TUBES		
	*Physical characteristic & construction of electron tubes & sockets		
	Theory of tube & pin numbering systems		
Take voltage & frequency readings with oscilloscope	*Operating theory of vacuum tubes (rectifiers & amplifiers)	Purpose, function & operation of tube testers	**Films 117, 118, 119, 120, 121
Make characteristic curve experiment on vacuum tube	Theory & characteristic curves of vacuum tubes		Film 72
	*Types & classification of vacuum tubes		
	*Vacuum tube terminology		
Construct simple tube receiver	*Purpose & operating theory of vacuum-tube grids		Films 117, 121
Construct power supply	Typical operating conditions of vacuum tubes		

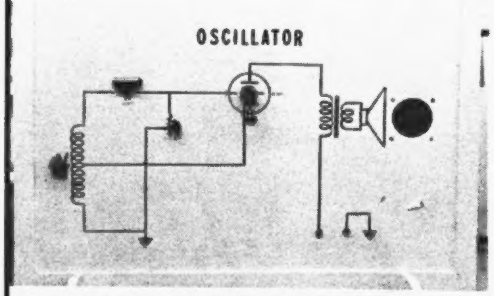
**Check reference numbers at end of unit.

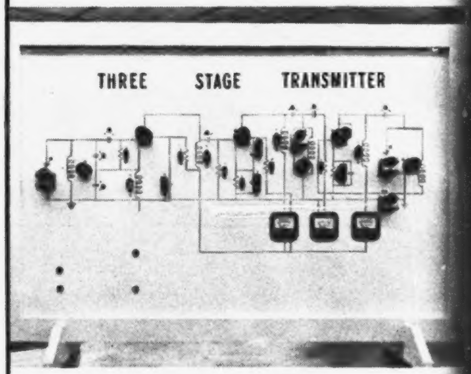
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
		Special characteristics of vacuum tubes	Film 72
		Tube parameters & dynamic characteristic of vacuum tubes	
Look up various tubes & state their operating conditions	*Function & use of the tube manual in electronics		Vacuum tube mock-up showing grids & physical arrangement of tube construction
	SEMI-CONDUCTORS Effect, purpose & development of miniturization in electronic components		
		Future developments & applications of semi-conductors	
Construct simple transistor receiver; or metronome, code practice oscillator, wireless microphone, light flasher, intercom, etc.	*Theory & operation of semi-conductors		Films 104, 116 
	Physical properties of semi-conductors		
Test diodes & transistors on tester	Construction of semiconductors	Semi-conductor testing devices & techniques	

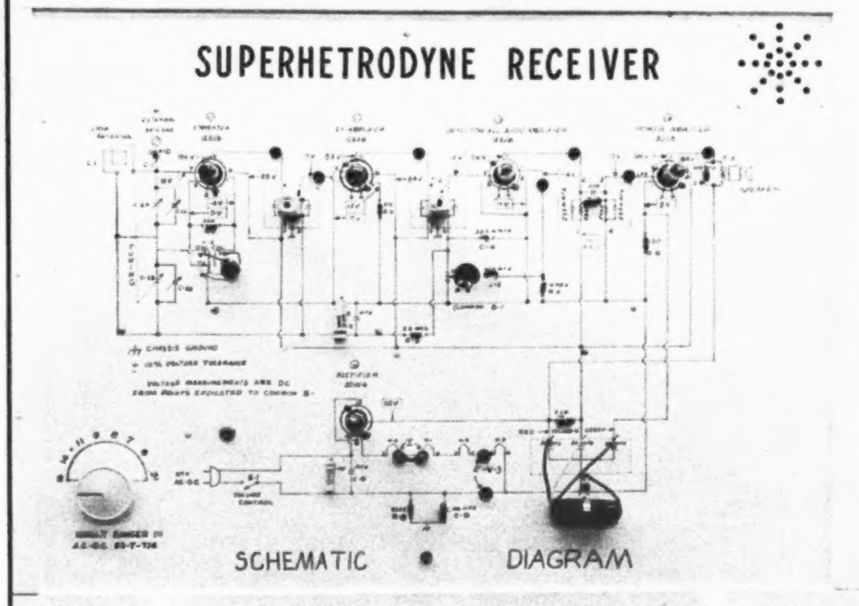
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	*Precautions & techniques in handling semi-conductors	 2N410 1st I-F AMPLIFIER 2N410 2nd I-F AMPLIFIER 2N408 2N408 OUTPUT FERRITE ANTENNA 2N412 CONVERTER DRIVER TRANSFORMER RCA TRANSISTOR RADIO DYNAMIC DEMONSTRATOR 6 VOLTS DC 4 RCA BATTERIES SWITCH ON VOLUME CONTROL	
	POWER SUPPLIES		
Work problems involving power supplies	*Types of power supplies	Ratings of power supplies	 
	*Power supply requirements for circuits & components	Purpose of power supplies	
Construct power supply	*Types. functions & developments of radio batteries (A, B, & C)	Construction of power supplies	
	Theory & application of transistorized power supplies	Regulation of power supplies	

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	*Theory, types & applications of rectifiers		Film 120 
	Theory, types & application of filter circuits		
	Theory & application of voltage divider networks		
Make tests on various power supplies		Repair & maintainence of power supplies	
		Purpose, function & operation of voltage doubler & tripler networks & circuits	
		Theory & operation of vibrator power supplies	
	AMPLIFIERS		
	*Physical nature of sound		
		Development of harmonics & their effects in electronics	

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	*Electrical transmission & reproduction of sound		
		Requirements & developments of high-fidelity & stereophonic sound systems (Decibles, wattage)	Explain the DB scale on the V.O.M. and how it is used
Construct amplifier	Types, applications & classes of amplifiers (A, AB, B, C)		Film 99
	Theory & operation of various types of amplifier circuits (RF, IF, AF, Push-pull & parallel or power)		Film 117
Connect & match audio inputs & outputs to amplifier	Types & operation of common amplifier coupling circuits		
Take voltage & current measurements of amplifier & figure watts output or input	Rating & measurement of amplifier output	Need for temperature stabilization in transistor amplifiers	
	*Comparison of vacuum tube & transistor amplifiers (physical & circuit diagrams)		
	Methods of biasing vacuum-tube & transistor amplifiers		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Operation & purpose of amplifier control circuits	Theory & operation of volume control circuits	
	Types & theory of feedback in amplifiers (regenerative & degenerative)		
	Purpose & need for decoupling circuits		
	*Methods & need for circuit shielding		
	Theory, operation & application of magnetic amplifiers		
	OSCILLATORS		
	*Purpose, function & operation of electronic oscillator		Film 99
Experiment with or construct oscillator circuit	*Methods of feeding oscillator circuit		
	Types & theory of LC oscillators		Films 98, 109 
	Types & theory of RC oscillators		
	Purpose & operation of frequency controls		
	Types & applications of commercial signal generators (AF & RF)		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	TRANSMITTERS		
	*FCC regulations regarding radio wave propagation		
Construct low power AM transmitter (100 milliwatts maximum and modulate)	*Types, theory & operation of AM transmitters		Film 106
		Type, theory & operation of FM transmitters	
	Methods of modulating or keying AM transmitters		Film 108
		Methods of modulating or keying FM transmitters	
Methods of coupling transmitter circuits			
	Purpose and need for carrier frequency stabilization		
	*Nature, characteristics & theory of radio waves		Films 69, 107
	*Theory of electromagnetic wave propagation		
	Types, characteristics & theory of transmission lines & antennas		Film 105

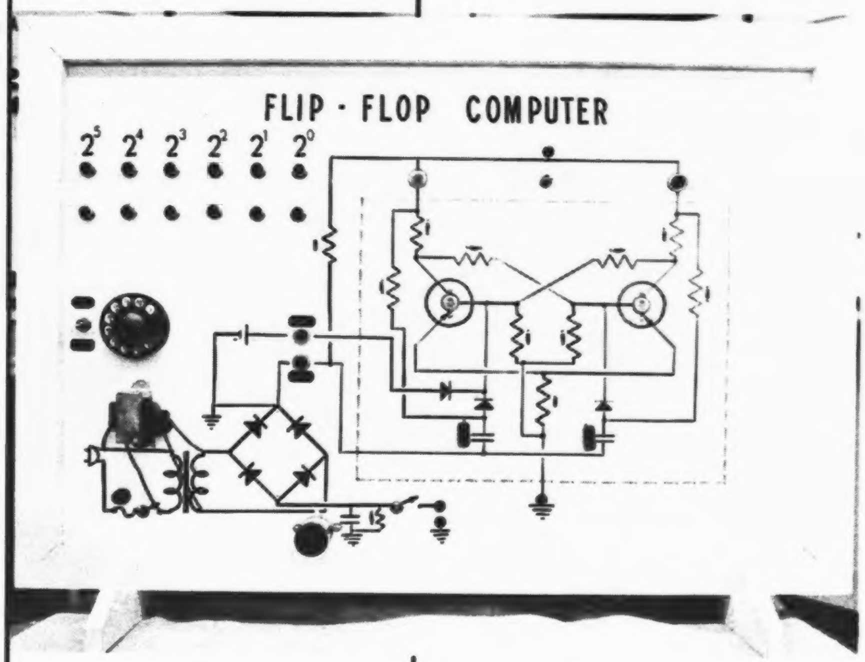
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
		Purpose & operation of sideband transmission	
		Principles of TV transmission	
		Theory of microwave transmission	
	*Theorys & types of transducers (microphones & speakers)		
	RECEIVERS		
Construct or experiment with a simple AM receiver	*Types, characteristics & theory of AM receivers		Trip to local radio or TV station for insights of basic operation
		Types, characteristics & theory of FM receivers	
	Methods & limitations of demodulation in AM receivers		
		Methods & limitations of demodulation in FM receivers	
Allign a detuned AM superhetrodyne receiver	Theory & procedure of AM receiver alignment		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Repair inoperable AM receiver		Theory & procedure of FM receiver alignment	
Note: A series of operations or activities might be laid out around several units, oscillators, amplifiers, etc., that would ultimately result in a superhetrodyne or low power transmitter		Methods & procedures of radio repair & trouble-shooting	
		Theory & types of time-delay circuits	
		Theory of logic circuitry	
		Principles of gating & counting circuits	
		Theory of TV receivers	

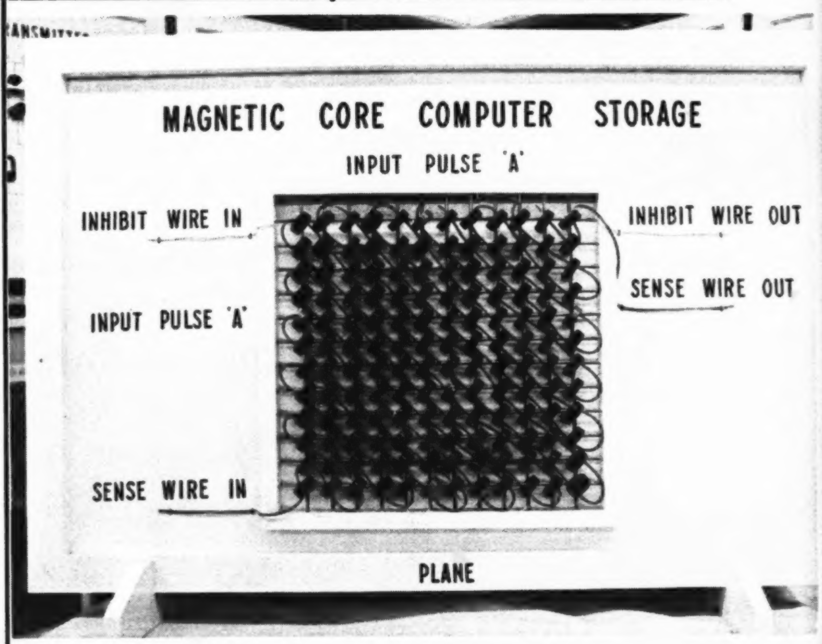
Applications Of Electronics

This section of the outline is devoted to the two main applications of electronics. Electronics in industry and electronics in the home. The line of demarcation is not definite, but the materials are separated for ease of identification.

This section is provided in the study guide to give some guidance to leaders who wish to pursue the field of electricity and electronics in greater breadth. The applications listed are not comprehensive but are intended as a guide to major developments for which information is available and of basic importance.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	INDUSTRIAL APPLICATION OF ELECTRONICS **Automation**		
	Definition of mechanization, automatic, mechanization, and automation		
		Early examples of automated devices	
	Technological change and automation (social and educational impact)		
Computers	Principle and significance of feedback in automation Computer mathematics (base 10 to base 2 and base 8)		
	Principles of logic circuitry		
	Types, application & function of computers digital, analog, bionic)		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Types, function & operation of computer storage devices		


MAGNETIC CORE COMPUTER STORAGE
INPUT PULSE 'A'
INHIBIT WIRE IN
INHIBIT WIRE OUT
SENSE WIRE OUT
INPUT PULSE 'A'
SENSE WIRE IN
PLANE

Production of Electrical Energy

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Theory & operation of fuel cells		
	Applications, advantages & disadvantages of fuel cells		
	Theory & applications of Bio-electrogenesis		
	Theory & applications of solar cells		

Industrial Controls

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Theory & operation of Servo Mechanisms		
	Operation, theory, & application of static switching devices		
	Theory, application, & operation of Syncronous devices		
	Theory & application of detection and sensing devices		
	Theory & application of magnetic amplifiers		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Industrial Processes		
	Types, applications & theory of magnetic forming of materials		
		Types of magnetic materials & theory of magnetic design	
	Theory, operation & application of high-frequency (induction heating)		
	Purpose, theory & applications of ultra-sonic cleaning		
	Theory & application of electron beam welding		
	Operation, application & theory of lasers & masers		
	History, theory & applications of electroplating		
	Theory & applications of RADAR and SONAR		
		Function, operation & theory of inertial guidance systems in space travel	
	Theory & applications of electro-luminescence		
	Technique, theory & application of facsimile reproduction		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Impact, application & theory of thin film & flexible electronic circuitry		
	History & applications of micro-miniturization of electronic modules		
	Technique & procedure of making sintered & printed circuits		
		Precautions & advantages of printed & sintered circuits in electronics	
	History & development of electronics in modern medicine (anesthesia, X-ray, surgery, etc.)		
	Applications of Electronics in the Home		
	Operation & maintenance of public address systems & intercoms		
	Theory, operation & applications of high-fidelity & stereophonic sound systems		
	Theory, types & applications of magnetic tape recorders		
	Theory & application of television		
	Theory, operation & applications of Radio Control devices		

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Theory & applications of Amateur Radio Theory & operation of transistorized ignition systems		

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55. *Bell Laboratories Record*

56. *Control Engineering*

57. *Design Engineering*

58. *Electronics Illustrated*

59. *Electronics World*

60. *High Frequency Heating Review*, Lepel High Frequency Laboratories, Inc., 55th St. and 37th Ave., Woodside 77, New York.

61. *Popular Electronics*

62. *Popular Science*

63. *Radio and Electronics*

64. *Radio-TV Experimenter*

65. *Science Experimenter*

66. *Science and Mechanics*

Films and Filmstrips—Electricity and Electronics

Film ordering key information:

EBF—Encyclopedia Britannica Films

MH—McGraw-Hill

SVE—Society for Visual Education

TAI—Teaching Aids Incorporated

Instructors will be able to order these films from the film libraries located at Southern State College, Pueblo; Colorado State College, Greeley; or Colorado University, Boulder.

Films:

67. *Alternating Current Theory*. 25 min., color, EBF 48523.
68. *Amperes, Volts, and Ohms*. 10 min., b & w, TAI HS-1102.
69. *Antenna Fundamentals—Propagation*. 13 min., MH.
70. *Basic Electricity*. 25 min., b & w, TAI HS-1005.
71. *Capacitance*. 25 min., color, EBF 48510.
72. *Characteristics of Vacuum Tubes*. 25 min., color, EBF 48553.
73. *Coulomb's Law—Electronics*. 25 min., color, EBF 48502.
74. *Coulomb's Law—Magnetism*. 25 min., color, EBF 48521.
75. *Effects of Electric Currents*. 25 min., color, EBF
76. *The Electric Field and Potential*. 25 min., color, 48515. EBF 48508.
77. *Electric Motors*. 25 min., color, EBF 48517.
78. *Electrical Equivalent of Heat*. 25 min., color, EBF 48516.
79. *Electricity at Rest*. 25 min., color, EBF 48501.
80. *Electricity in Motion*. 25 min., color, EBF 48503.
81. *Electromagnetic Waves*. 25 min., color, EBF 48551.
82. *Electromotive Force of A Battery Cell*. 25 min., color, EBF 48504.
83. *Electrons*. 11 min., b & w, EBF 258.
84. *Electrons at Work*. 14 min., color, EBF 1888.
85. *Electrostatics* (second edition). 11 min., b & w, EBF 467.
86. *Elements of Electrical Circuits*. 11 min., b & w, EBF 214.
87. *How to Produce Electric Current with Magnets*. 11 min., color, EBF 182.
88. *How Vacuum Tubes Work*. 17½ min., color, MH.
89. *Induced Electric Currents*. 25 min., color, EBF 48520.
90. *Magnetic Fields*. 25 min., color, EBF 48513.
91. *Magnetic Induction*. 25 min., color, EBF 48518.
92. *Magnetism*. 25 min., color, EBF 38512.
93. *Magnetism*. 16 min., b & w, EBF 764.
94. *Magnetism and Electricity*. 17 min., color, MH.
95. *Ohm's Law*. 5 min., color, Coronet.
96. *Ohm's Law*. 25 min., color, EBF 48505.
97. *Ohm's Law*. 19 min., b & w, TAI HS-1001.
98. *Oscillators*. 13 min., b & w, TAI HS-1107.
99. *Oscillators, Amplifiers and Radio*. 25 min., color, EBF 48554.
100. *Parallel Circuits*. 25 min., color, EBF 48507.
101. *Parallel Resistances*. 25 min., color, EBF 48509.
102. *The Potential Divider*. 25 min., color, EBF 48511.
103. *The Primary Cell*. 11 min., b & w, EBF 247.
104. *Principles of the Transistor*. 21 min., b & w, MH.
105. *Radio Antennas—Fundamentals*. 13 min., b & w, TAI HS-1117.
106. *Radio Transmitters—Principles and Typical Circuits*. 18 min., b & w, TAI HS-1118.
107. *Radio Waves*. 27 min., color, MH.
108. *The RF Amplifier and Modulator*. 10 min., b & w, TAI HS-1121.
109. *The RF Oscillator*. 17 min., b & w, TAI HS-1120.
110. *Series Circuits*. 25 min., color, EBF 48506.
111. *Series and Parallel Circuits*. 11 min., b & w, EBF 259.
112. *Series and Parallel Circuits*. 10 min., b & w, TAI HS-1101.
113. *A Study of Motors*. 25 min., color, EBF 48519.
114. *Transformers*. 25 min., color, EBF 48524.
115. *Transformers*. 25 min., color, EBF 48522.
116. *Transistor*. 9½ min., b & w, Bell Tel Co.

117. *The Triode: Amplification.* 14 min., b & w, TAI HS-970.

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120. *Vacuum Tubes—Electron Theory and the Diode.* 16 min., b & w, TAI HS-974.

121. *Vacuum Tubes—Triode and Multipurpose Tubes.* 12 min., b & w, TAI HS-973.

122. *What is Electric Current?* 14 min., color, EBF 1880.

123. *What is Electricity?* 13 min., b & w, EBF 765.

124. *Wheatstone Bridge.* 25 min., color, EBF 48514.

Filmstrips:

125. *Electrical Circuits.* 57 frames, SVE 482-6.

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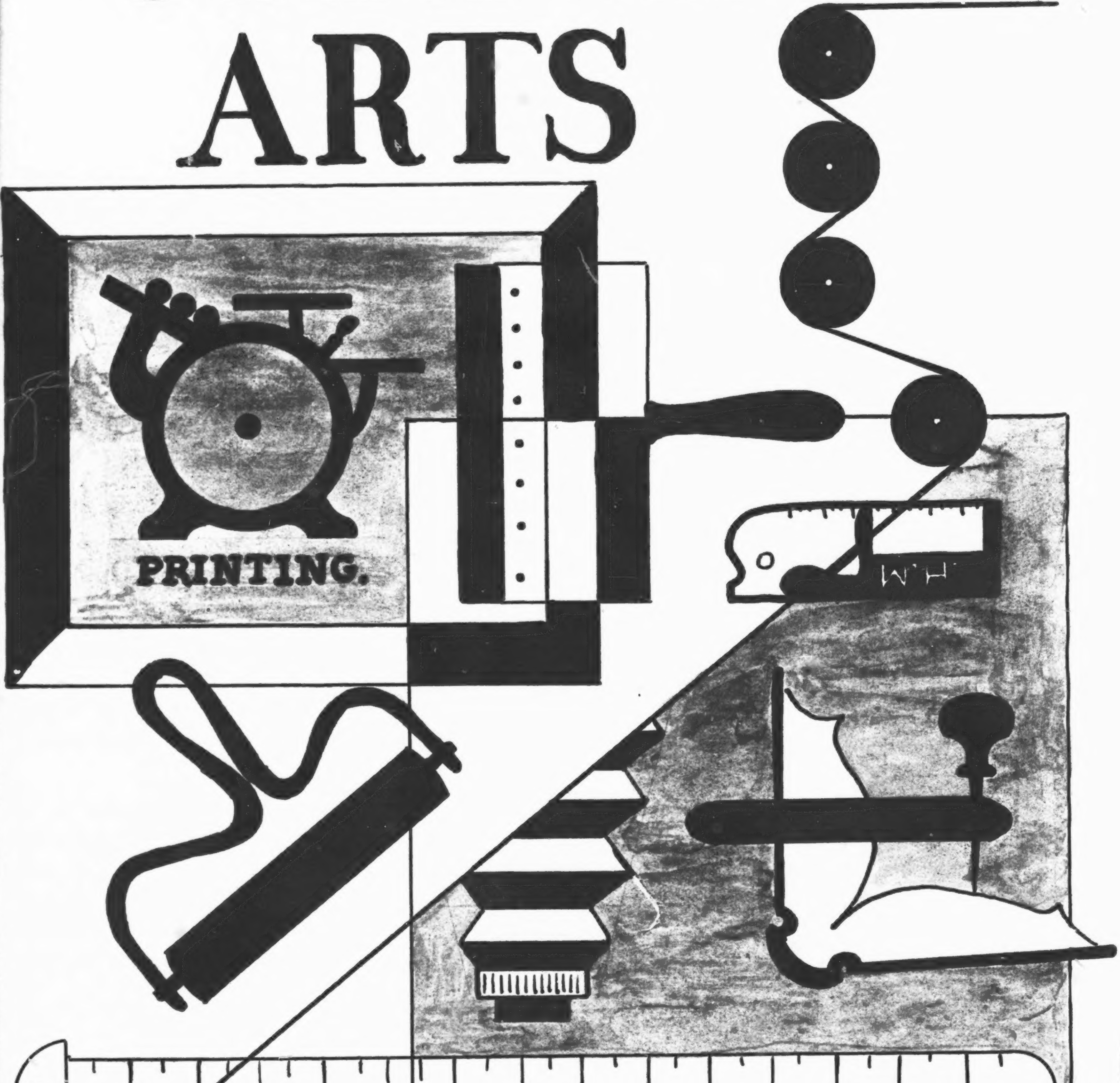
GRAPHIC ARTS



CHAPTER XII

GRAPHIC ARTS

One of the most important factors in man's advance from barbarism has been the perfecting of the communications system providing a constant interchange of knowledge and opinion. Through the centuries there has come the development of communication in which man gains knowledge and transmits it from generation to generation.

Graphic Arts has played an important part in the process of progressive growth of civilization and today is one of the fastest growing industries.

When teaching Graphic Arts, the teacher must keep several objectives in mind.

1. To have the student explore and become acquainted with the basic mechanics of Graphic Arts reproduction.
2. To help the student appreciate the many scientific and technical aspects necessary to produce good printed material.
3. To enable the student to learn the many interesting facts about the history of printing.
4. To acquaint the student with the career opportunities in the graphic arts industry.

In general, graphic arts education should teach the student to understand and appreciate the many ways of producing printed material.

Note:

The suggested instructional material is not necessarily placed across from the proper operation, but it should be used for the complete unit. This was done because of duplication and overlapping.

LAYOUT & DESIGN

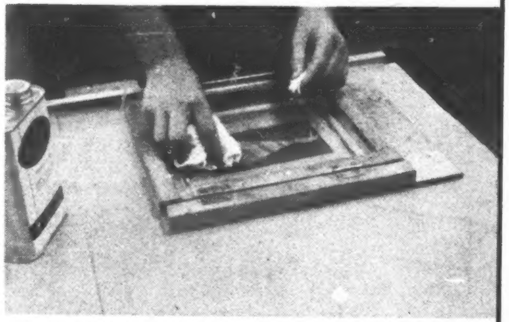
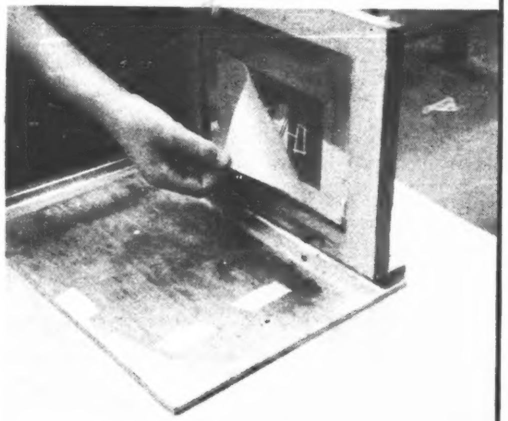
Operations	Fundamental Knowledge	Related Information	Instructional Materials
Prepare a design	Principles of design Principles of design and color	History of paper and paper classification	Charts
Make layout, drawing, or thumbnail sketch	Principles of typographic style	Theory of color and design	Films 52, 59
Make a dummy	Practical application of graphic arts mathematics		Models and displays
Determine color scheme, ink, and stock	Principles of display type classification	Care of inks Composition of inks Drying action of inks History of inks	Field trips

Operations	Fundamental Knowledge	Related Information	Instructional Materials
Read, mark, and revise dummy	Common technical terms of the printer		Publications
Read proofs	Proof marks, common rules of spelling, grammar, and punctuation		Books 5, 6, 10, 14, 28
COPY PREPARATION			
	COMPOSITION		
Work with type case LEVER HEAD COPY	Design principle of California job case Lay of common type cases	Historical background of relief printing History of the alphabet Other types of cases and their use	Charts
Hold and adjust composing stick	Point system of measurement	Great printers in the past	American Type Founders
Letter space type	Recognize spacing material	Ingredients in type metal	Printed samples
Set simple straight matter	Space in or space out of line	History of type	Films 37, 39, 45, 53, 54, 69
Justify lines	Test for justification		Models

Operations	Fundamental Knowledge	Related Information	Instructional Materials
Dump the stick			Enlarged pieces of type, spacing material, and line gauge
Tie up a type form			
Take proof of type set			
Read and correct proof			
Make corrections	Use of cleaning fluids		
Set initial letters	Use of caps and small case letters		
Set conventional layouts	Space composition correctly	Design in printing	
Use different styles of type	Fonting schemes Type series and families	Development of type design	
Set special type and type forms	Use of special type, borders, ornaments, and initials		
Cut with a mitering machine	Use of mitering machine		
Set tabular and ruled forms	Kinds of brass and strip rule		
Set piece and strip borders			
Set display matter	Type harmony		
Print multicolor forms		Occupations in graphic arts	

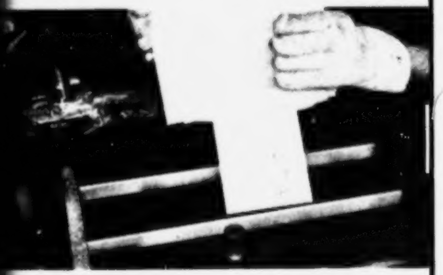
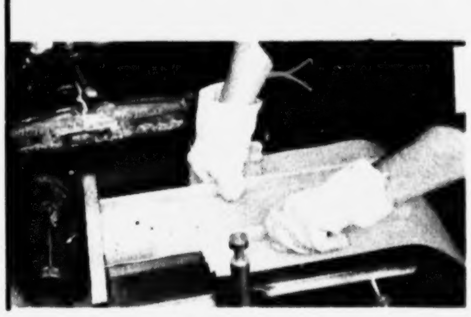
Operations	Fundamental Knowledge	Related Information	Instructional Materials
Machine composition (if composing machinery is available)		Safety information	
	PHOTOGRAPHIC TECH.		
Take different types of pictures	Principles of the camera Types of cameras	History of photography Occupations of photography	Information
Develop exposed film	Use of developers and fixers	Safety information	Photo-lathe, Graphic Electronics, LaSalle, Ill.
Make contacts	Contact printing	Hobbies in graphic arts	Eastman Kodak Co.
Enlarge photographs	Principles of enlargers		Samples of photographic copy
Print pictures	Types and uses of films and paper		
Trim and mount pictures			
Prepare copy	Use of color filter	Color separation Use of photography in the Graphic Arts	
Expose and develop line negative	Theory of Photolithography	Use of lithography	
Expose and develop halftone	Use of continuous tone pictures		
Lithographic paste-up	Combining line and halftone work	Photo-Lathe	
	Xerography	Electronic composition Xerography	

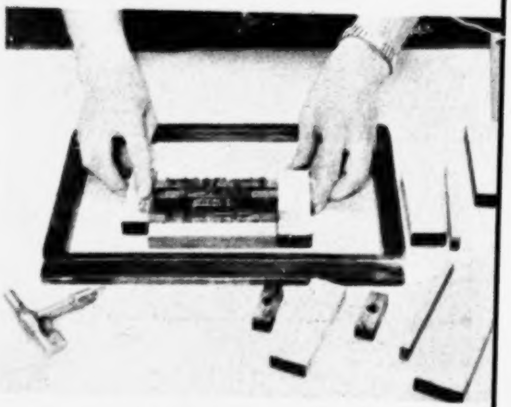
PRINTING PROCESSES

Operations	Fundamental Knowledge	Related Information	Instructional Materials
	SILK SCREEN		
	Adaptability of the silk screen process	Historical background of screen process Importance of screen Uses of screen process The screen process industry Job opportunities in the silk screen industry	Films 68, 72
Prepare design 	Methods of making silk screen design Layouts for screen processes	Safety information	Samples of silk screen printing
Select desirable silk screen method 	Different screen process methods Kinds of screen Various types of stencils available	Electrostatic plate making	
Prepare silk screen frame for print	Adhere stencil	Cost of silk	

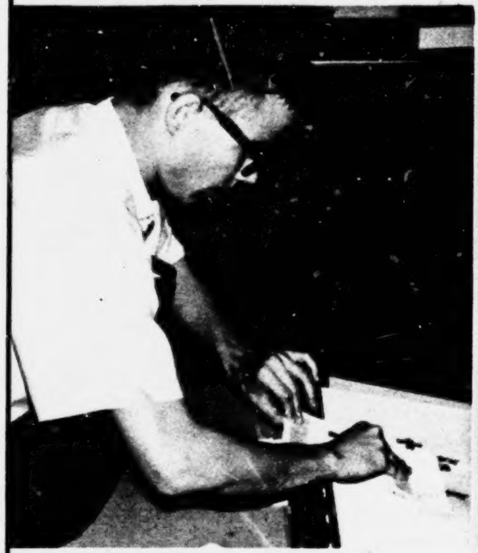
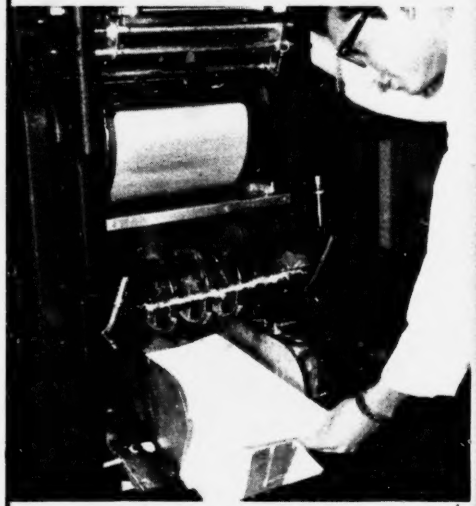
Operations	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Cut stencil	Block out balance of screen	Cost of stencil film Organdy may be cheap substitute Photographic process	
Blockout	Application of blockout media	Various blockout media	
	ROTOGRAVURE		
	Principles of gravure printing Types of intaglio (line etching, line engraving, drypoint)	Industrial use of gravure printing Study of engraving	Films 45, 53, 58
Make a celluloid line engraving	Rotogravure processes	Line etching	Samples of intaglio printing
Metal plates 	Gravure operations Gravure ink	Halftone Conventional etching Powerless etching Register process	Field trips

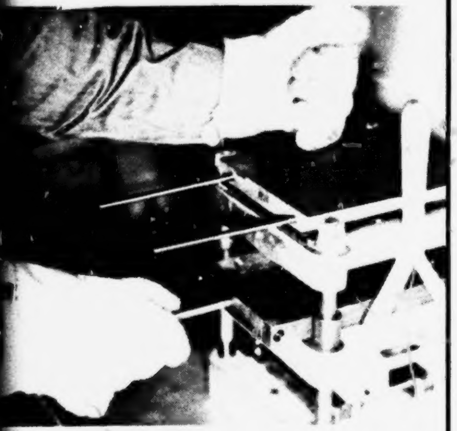
Operations	Fundamental Knowledge	Related Information	Instructional Materials
Plastic plates 		Color printing Color scanning devices Automatic engraving machine Polymer plastic plates	Information from gravure manufacturers
	LITHOGRAPHIC		
	Offset papers and inks	History of lithography Occupations of lithography	Films 47, 56, 66, 67, 74
Strip flats NUMBER PLEASE	Preparing negatives Stripping flats		Charts
Prepare chemicals	Mixing chemicals	Various chemicals and uses Safety information	Printed examples
Burn plates	Types of plates Plate preparations	Plate terminology and types Kinds of lamps	Information from lithographic companies

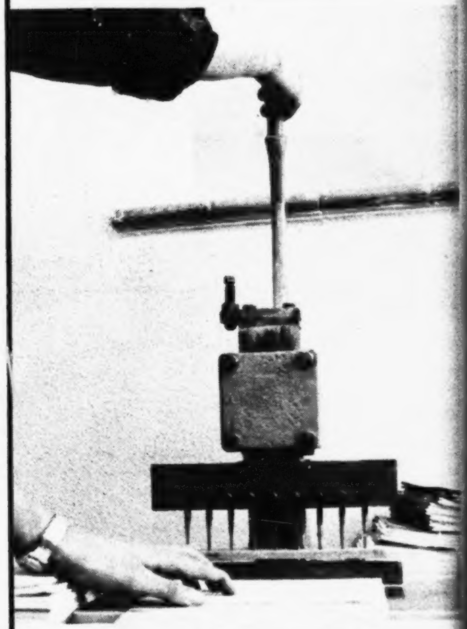
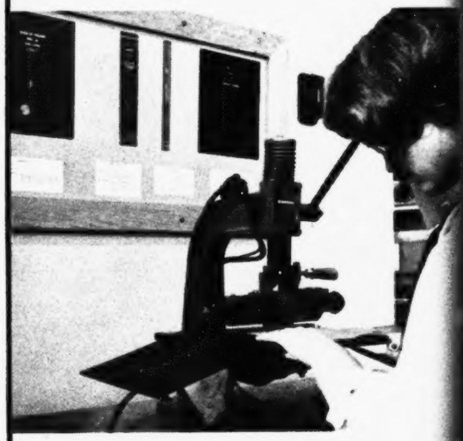
Operations	Fundamental Knowledge	Related Information	Instructional Materials
	LINOLEUM BLOCK		
	Methods used in the past Basic difference of relief and intaglio	History of block carving Opportunities in block carving	Film 48
Prepare design	Multiple color registration	How to mount linoleum on blocks	Printed examples
Transfer to block	Reversing design		
Cut block	Use and care of cutting tools	Cost and types of cutting tools Safety information	
	STEREOTYPE		
	Materials and equipment used in the stereotype process	Uses of the stereo method in the printing industry Electro types	Film 53
Selection of design	Molding the stereotype mat	Other duplicate platemaking	Charts
Preparation of mat	Positioning mat Heat control	Types of plates	

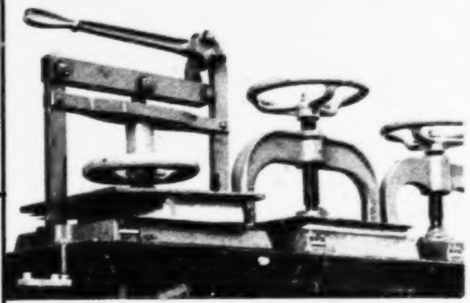
Operations	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Make a stereotype casting	Casting the stereotype plate Routing and trimming Mounting the stereotype plate	Safety information	
Melt and clean metal	Metal information		
	RELIEF PRINTING		
Make up and tie jobs in galley 	Principles of job layout	Copyright laws Development of the point system	Films 52, 53
Pull stone proof	Plane form	Importance of accuracy and neatness	Models
Position a form for lock-up	Position type form within chase	Common sizes in font of furniture	Lock-up and lock-up methods
Position furniture and and lock-up for printing	Use of reglets Use of quoins Care of material used in imposition	Types of furniture	

Operations	Fundamental Knowledge	Related Information	Instructional Materials
Lock-up jobs in chase	Lock-up by square and chaser methods Test form for lift	Types of quoins	
Unlock and distribute material			
Lock-up Work and tumble Work and turn Work and flop Work and twist Work and back Multi-page	Imposition Use of numbering machines	Types of printing presses and their products Safety information	
INK TRANSFER	**DIRECT FROM TYPE**		
Preparation 	Cut paper Ink mixing Care of inks Drying action of inks	Kinds of paper and inks	Illustrations
Operate proof press	Pulling proofs	Types of proofing	Films 36, 69, 71
Prepare press for printing	Parts of the press Proper angle and pressure of squeegee Roller care and adjustment Press adjustment and maintenance	Kinds of rollers and their composition Safety information	Field trips

Operations	Fundamental Knowledge	Related Information	Instructional Materials
Set up and run job on press	Proper press procedure Location of gauge pins Registration and make ready Press feeding Slip sheeting and drying	Kinds of presses	
Remove job and clean press	Press clean-up and maintenance	Types of cleaning solvents	
If automatic presses are available, instruction should be given on this level	Setting of automatic feders and deliveries		
	PLATES — DIRECT AND INDIRECT		
Operate offset press	Types of plates Papers and inks Press operation "Colo" type processes	Gravure presses Photo copying machines Types of offset and gravure printing Kinds of paper and inks	Films 40, 54

Operations	Fundamental Knowledge	Related Information	Instructional Materials
	SPECIAL PROCESSES		
Emboss, score, die cut, and perforate sheets 	Equipment functions and processes	Types of moldings and mountings Various materials	Information from companies
Virkotyping	Application of ink and powder	Types of powder	Field trips
Print by silk screen	Proper ink consistency Control register	Silk screen production printing Pressureless printing	
Clean silk screen	Proper care and use of Cleaning material	Cleaning solvents	
Rubber stamp	Methods used in making rubber stamp	Use of rubber molds in the printing industry	
BINDING			
Introduction to binding	Kinds of tools and equipment 	History of binding The work of the librarian Book care and use Kinds of materials used in binding and finishing Uses of the binding processes	Films 38, 41, 42, 43, 44, 49, 53, 57

Operations	Fundamental Knowledge	Related Information	Instructional Materials
Cut stock	Method of figuring and cutting stock	Safety information	Samples of different types of binding
Prepare and make pads	Perforating Padding methods		Visual aid showing steps in making library and nicked corners
Wire stitch	Different kinds of stitches and sewing used in binding		Cutting chart
Marbling paper	Thinning ink Use of comb Dropping on water Drying paper	History of marbled paper	
Assemble and jog papers	Ways of assembling and jogging papers Jogging, cutting, gathering, and folding paper	Folding machines	
Make autograph books with hard covers	Binding of small booklets Make a nicked corner Slide and saddle stitch methods	Binding of small booklets	

Operations	Fundamental Knowledge	Related Information	Instructional Materials
Bind books	Procedures for bookbinding Ways of assembling Make a library corner	Mechanical bindings	
ALLIED INDUSTRIES			
	NEWSPAPER		
The units in newspaper operations are studied through lectures, demonstrations, and not laboratory operations	Use of character count in headlines and ads	Importance of newspaper Paper industry	Films 46, 59, 60
	Spacing materials used for newspaper		Samples of newspapers
	Planning gutters and margins		
	Page makeup		
	Justifying columns to length	Type foundry	
	Responsibilities of proofreader		
	Use of proofreader's marks		
	Mounting cuts, Fairchilds, and engravings	Graphic Arts chemicals Manufacturing of printing inks Manufacturing of printing plates	
	Locking news form in press bed	Safety information	
	Press operation	Manufacturing of printing machines	

Operations	Fundamental Knowledge	Related Information	Instructional Materials
	Office style feeder and delivery settings		
	Setting of automatic feeders and deliveries		
	BUSINESS OF PRINTING		
		Research and development Advertising Sales Labor management Distribution	Periodicals Publications Field trips Films 50, 51

SUGGESTED PROJECTS

Planning

- Make thumbnail sketch, rough layout and finished layout of:
- Display work
- Advertisements
- Program or menu
- Booklet—4 or 8 pages
- Ticket
- Business stationery
- Personal stationery
- Announcement
- Personal calling cards
- Shipping label
- Coasters
- Projects of your own choice

Lock-up

Screen Process

- Posters
- Book covers
- Christmas and other greeting cards
- Projects of your own choice

Hand Composition

- Set type for layouts designed in planning sections

Press Work (Power)

- Print jobs, individual selections

Photography

- Expose a roll of film with a variety of situations:
- Outside-day
- Outside-night
- Inside-day
- Inside-flash
- Develope contact print and enlarge at least two

Rubber Stamps

- A rubber stamp of your name
- A rubber plate for printing

Steretotype

- Roll a mat of a type form
- (Be sure to use bearers)
- Cast a plate from mat
- Cast a plate from a commercial matrix

Platemaking Linoleum

Block

- Design and cut a two-color block and register
- Poster
- Cover
- Christmas card

Binding

- Cut stock for jobs in previous sections.
- Bind book different methods

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4. Carlsen, Darvey E. *Graphic Arts.* Peoria, Ill.: Chas A. Bennett Co., 1958. 158 pp.
5. Clark, Merle A. *Student Printing.* Peoria, Ill.: Chas A. Bennett Co. 95 pp.
6. Cleeton, Glen U. *General Printing.* Bloomington, Ill.: McKnight and McKnight, 1963. 203 pp.
7. Cogoli, John. *Photo-offset Fundamentals.* Bloomington, Ill.: McKnight and McKnight, 1960. 209 pp.
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9. Groneman, Chris H. *General Bookbinding.* Bloomington, Ill.: McKnight and McKnight, 1946. 64 pp.
10. Hague, Clifford W. *Printing and Allied Graphic Arts.* Milwaukee: Bruce Publishing Co., 1957, 256 pp.
11. Johnson, William H., and Newkirk, Louis V. *The Graphic Arts.* New York.:The Macmillan Co., 1949.
12. Kafka, Francis J. *Linoleum Block Printing.* Bloomington, Ill.: McKnight and McKnight, 1955. 84 pp.
13. Kagy, Fred D. *Graphic Arts.* Homewood, Ill.: Goodheart-Wilcox Co., 1961. 112 pp.
14. Karch, R. Randolph. *Graphic Arts Procedures.* Chicago: American Technical Society, 1958. 383 pp.
15. Karch, R. Randolph. *Graphic Arts Procedures.* Third edition. Chicago: American Technical Society, 1965. 383 pp.
16. Karch, R. Randolph. *How to Recognize Type Faces.* Revised. Bloomington, Ill.: McKnight and McKnight, 1959. 265 pp.
17. Kauffmann, Desire. *Graphic Arts Crafts.* Princeton, N. J.: D. Van Nostrand Co., 1955.
18. Klinefeller, Lee M. *Bookbinding Made Easy.* Milwaukee: Bruce Publishing Co. 96 pp.
19. Kosloff, Albert. *The Art and Craft of Screen Process Printing.* Milwaukee: Bruce Publishing Co. 188 pp.
20. Lush, Clifford K. *Junior Letterpress and Lithography.* Peoria, Ill.: Chas. A. Bennett Co., 1963. 80 pp.
21. Marinaccio, Anthony, and Osborn, Burl N. *Exploring the Graphic Arts.* Scranton, Pa.: International Textbook Co., 1942. 274 pp.
22. McCombs, Kenneth M. *Commercial Photography.* Chicago: American Technical Society, 1960.
23. McCoy, Robert A. *Practical Photography.* Revised. Bloomington, Ill.: McKnight and McKnight, 1959. 283 pp.
24. Miller, Thomas H., and Brummit, Wyatt. *This is Photography.* Garden City, N. Y.: Garden City Publishing Co., 1959. 260 pp.
25. Ogg, Oscar. *The 26 Letters.* New York: Thomas Crowell Co., 1948. 254 pp.
26. Perry, W. F., and Baab, C. T. *The Binding of Books.* Revised. Ueoria, Ill.: Chas. A. Bennett Co., 1964. 160 pp.
27. Polk, Ralph W. *Elementary Platen Press.* Peoria, Ill.: Chas. A. Bennett Co., 1955. 148 pp.
28. Polk, Ralph W. *The Practice of Printing.* Revised. Ueoria, Ill.: Chas A. Bennett Co., 1964. 328 pp.

Periodicals

29. *American Pressman,* International Printing Pressman's Union, Pressman's Home, Tennessee.
30. *American Printer,* 9 East 38th Street, New York 16, New York.
31. *Graphic Arts Monthly,* Graphic Arts Publishing Company, 608 South Dearborn Street, Chicago 5, Illinois.
32. *In Plant Printer,* United Business Publications, 200 Madison Avenue, New York 16, New York.
33. *Inland Printer,* 309 West Jackson Boulevard, Chicago 6, Illinois.
34. *Printing,* Walden, Sons & Mott, Inc., 466 Kinderkamack Road, Oradell, New Jersey.
35. *Reproduction Methods,* Gellert-Wolfman Publishing Company, 33 West 60th Street, New York 23, New York.

Films — Graphic Arts

Film ordering key information:

When ordering films listed in this index, it is suggested that the order be written on official school letterhead as many of the films are available only to authorized educational institutions. When ordering films directly from the companies listed, state that the film is desired for industrial education classes, as many films are available for showing only to this group.

When ordering films to be shown on a specific date, order the films well in advance of the desired date of showing. Many companies state that to book a film for showing on a specific date the film must be ordered three months in advance.

BFI — Gailey Films Incorporated, 6509 De-Longpre Avenue, Hollywood 28, California.

CCP — Crowell-Collier Publishing Co., 640 Fifth Avenue, New York, New York.

CHA — Champion Paper and Fibre Co., Advertising Dept., Hamilton, Ohio.

DUC — C. T. Dearing Printing Co., Broadway at 11th Street, Louisville 1, Kentucky.

DRGWR CO — Denver and Rio Grande Western Railroad Co., Advertising Dept. (Films), U. O. Box 5482, Denver 17, Colorado.

EKC — Eastman Kodak Co., Rochester, New York.

G CO — Glatfelter Co. U. H., R. F. Alexander, Mgr., Advertising and Public Relations, 5900 Lemmon Avenue, Dallas 9, Texas.

HE CO — Horan Engraving Co., 44 West 28th Street, New York 1, New York.

HPP COR — Hudson Pulp and Paper Corporation, Advertising and Sales, Roanoke, Virginia.

HS CO or HSP — Harris Seybold Co., 4510 East 71st Street, Cleveland 5, Ohio.

ILL — Visual Aids Service, University of Illinois, Div. of University Extension, Champaign, Illinois.

IND — Audio-Visual Center, Indiana University, Bloomington, Indiana.

IPC — International Paper Co., 220 East 42nd Street, New York 17, New York.

IPINK — International Printing Ink, Division of Interchemical Corp., 67 West 44th Street, New York 17, New York.

ISC — Iowa State College, Visual Instruction Service, Ames, Iowa.

LINO — Mergenthaler Linotype Co., Brooklyn 5, New York.

MIN — University of Minnesota, Bureau of Audio-Visual Instruction, 229 Northrop Memorial Auditorium, Minneapolis 14, Minnesota.

MOD or MIP — Modern Talking Picture Service, 45 Rockefeller Plaza, New York 20, New York.

MPPM — Miehle Printing Press and Man. Co., Sales Department, 2011 Hastings Street, Chicago 8, Illinois.

NFBC — National Film Board of Canada, Suite 2307 RKO Building, 1270 Avenue of the Americas, New York 20, New York.

RAP — Rapid Electrotype Co., McMicken Avenue at Race, Cincinnati, Ohio.

SUI — State University of Iowa, Bureau of Audio-Visual Instruction, Extension Division, Iowa City, Iowa.

WIS — Bureau of Visual Instruction, University Extension Division, University of Wisconsin, Madison 6, Wisconsin.

WPL — Western Printing and Lithography Co., Personnel and Training Dept., 1220 Mound Avenue, Ravine, Wisconsin.

WRU — Western Reserve University, Audio Visual Center, Cleveland, Ohio.

Films

36. *Another Man's Business*. 20 min., color, MIL.
37. *Art and Technique of Photoengraving*. 27 min., color, HE CO.
38. *Bindery Operations*. 45 min., WPL.
39. *The Blue Streak Linotype Machine*. 25 min., LINO.
40. *Chemical Effects of Electricity*. 17 min., $1.50, IND.
41. *Elementary Bookbinding*. 10 min., $2.00, IND or ILL.
42. *From Pines to Paper*. 32 min., color, HPP COR.
43. *From Trees to Paper*. 12 min., 60c, ISC.
44. *Gift of Ts'lun—Paper*. 33 min., 60c, ISC.
45. *Heights and Depths*. 8 min., $1.50. IND, ILL, or MIN.
46. *Hemlock to Headlines*. 29 min., color, DRGWR CO.

47. *How to Make a Good Impression*. 21 min., color, 1947, HSP.

48. *How to Make a Linoleum Block Print*. 14 min., $3.50, BFI.

49. *In Partnership With Nature*. 20 min., color, 1951, IPC.

50. *In Perfect Balance*. 13 min., color, 1952, MPPM.

51. *Look to the Years Ahead*. 30 min., color, 1947, MPPM or MIE.

52. *Magazine Magic*. 34 min., MOD.

53. *The Making of a Magazine*. 43 min., color, DPC.

54. *Manufacturing of Electrotype and Mats*. 11 min., RAP.

55. *Miracle of Paper*. 23 min., color, 1955, G CO. (Not available to elem. schools.)

56. *Modern Photo-engraving*. 15 min., color, KC.

57. *New Books for Old*. 15 min., WRU.

58. *New Wings for Publishing*. 35 min., color, CCP.

59. *Newspaper Story*. 16 min., $2.50, SUI.

60. *Newsprint*. 23 min., NFBC.

61. *Paper*. 11 min., $2.00, MIN.

62. *Paper Comes to Life*. 30 min., CHA.

63. *Paper in the Making*. 24 min., color, MTP.

64. *Paper Making*. 22 min., $2.50, ISC, ILL, or IND.

65. *Paper and Pulp Making*. 11 min., $1.25, SUI.

66. *Photo Lithography*. 45 min., color, EKC.

67. *The Modern Lithographer*. 11 min., color, $1.25, SUI, ILL, WIS, IND, or MIN.

68. *Poster Making: Printing by Silk Screen*. 14 min., $7.50, BFI.

69. *Printing*. 11 min., $1.25, ISC and SUI.

70. *Printing Through the Ages*. 17 min., $2.50. SUI.

71. *Putting a Job on a Platen Press*. 11 min., $3.50, BFI.

72. *Rainbows to Order*. 21 min., color, IP INK.

73. *Silk Screen Process in Lithography*. 20 min., $2.50, SUI.

74. *Technique of Lithography*. 32 min., $3.50, IND.

75. *Trees to Tribunes*. 44 min., color, 60c, ISC or SUI.

MECHANICAL
DRAFTING
Mack Hoover

CHAPTER XIII

MECHANICAL DRAFTING

Mechanical drafting is the language of industry; that is, the means by which mechanical ideas are developed, recorded, and transmitted to others. It is the universal, graphic language which provides communication between industrial workers of the world. The term "mechanical drafting" is applied to work requiring, for the most part, the use of tools and instruments. However, freehand sketching must be considered an integral phase of drafting.

In this area of the industrial arts program, an attempt is made to do the following:

(1) Provide exploratory contacts with as many different types of drafting as possible

(2) Provide opportunities for general education, pre-engineering, and pre-vocational training facts about industry, machines, materials of construction and related occupations

(7) Develop the ability for accuracy and neatness in doing a job

(3) Teach usable skills in the production of working and pictorial drawings, freehand sketching and lettering

(4) Develop the ability to read and interpret drawings through mental visualization

(5) Develop the ability and habit of using drawing to plan jobs of a mechanical nature

(6) Present a variety of interesting and useful facts about industry, machines, materials of construction and related occupations

(7) Develop the ability for accuracy and neatness in doing a job

BASIC MECHANICAL DRAFTING

These units of instruction in mechanical drafting have been designed and developed in accordance with the definitions and objectives of industrial arts in general education. This course was designed to give the student background and a general overview of mechanical drafting. The units are flexible so that they may be adapted to the individual situation; however, they should be considered a minimum requirement for the school which offers a course in drafting.

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
*Introduction to mechanical drafting	Definition	History Vocational opportunities Uses	**Texts and references Films: 80, 88, 108, 82, 117 Guest specakers from industry
*Sketching	Purpose Types	Uses	Chalkboard, paper, pencils, eraser Films: 75, 85, 113
	Techniques		Solid models and Overhead projector
*Alphabet of lines	Line value Symbols		Chart: 127 Film: 74
*Geometric construction	Circles and arcs Angles Lines Bisecting lines, angles, and arcs Dividing straight lines into any number of equal parts Construction of hexagons, octagons, and pentagons	Importance in mechanical drafting Relationship to mathematics Application to general work problems	Chalkboard equipment Film: 116 Transparencies: 121,124 part 1
	Construction of ellipses, curves, involutes and spirals Tangents		

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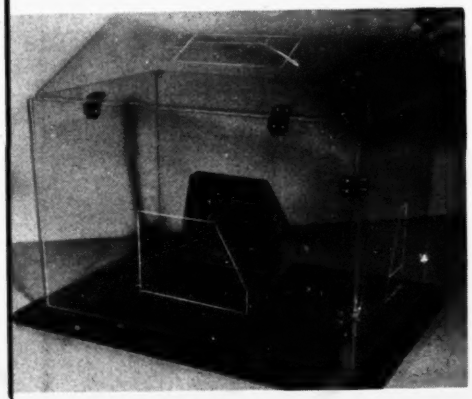
*Suggested for study in the comprehensive general shop.

**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Dimensioning	Extension lines Dimension lines Leaders Arrowheads Standard rules and practices Importance of clear and exact dimensioning	Unidirectional Aligned	Films: 110, 113 Chart: 129 Transparencies: 120, 140
*Materials and equipment	Importance of cleanliness Care of equipment Use of equipment Use of materials	Kinds and sources of materials and equipment	Texts and references Catalogs: All Film: 81
*Orthographic projection	Definition Method of projection Location of views Selection of views Relationship of planes Working drawings Detail and assembly drawings	Industrial drawing	Models Hinged, plastic box Films: 78, 95, 105, 106, 107 Pencils, paper, erasers, pencil pointer, scale, triangles and T-square Transparencies: 122, 124 Chart: 130 
*Lettering	Direction and sequence of strokes Proportion	History Styles Lettering devices	Charts: 132, 133, 134 Texts and references Films: 77, 89, 91 COLORADO INDUSTRIAL ARTS PROG

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Pictorial drawing *a. Isometric	Isometric lines Isometric scale Non-isometric lines Angles in isometric Curves in isometric Isometric circle Use of hidden lines Dimensioning Shading		Films: 97, 98 Clear plastic projection plane Transparencies: 123, 124 part 2
b. Oblique (1) Cavalier (2) Cabinet	Angles of receding lines Length of receding lines Choice of position Offset measurements Dimensioning Shading	Application	Transparency: 124 part 1
c. Perspective (1) One point (2) Two point (3) Three point	Position of station point Location of picture plane Location of horizon line Location of vanishing points	Uses Photography	Films: 47, 85 Transparencies: 123, 124 part 1
Sections	Half sections Full sections Broken sections Revolved sections Revolved features Removed sections Offset sections Cutting plane Section lines Conventional breaks Symbols	Detail shape Interior parts Industrial drawings in section Interrelated parts	Models and machines parts in section Films: 101, 102 Transparencies: 125, 124 part 2
Auxiliary views	Review of regular planes Definition of auxiliary plane Top, front, and side auxiliary views Reference plane Methods of plotting curves Partial views Auxiliary sections True shape	Conventional break lines Importance in the study of graphics	Sample objects with inclined planes Hinged, plastic box Films: 69, 70, 71 Transparency: 118 Chart: 130

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Revolutions	Simple revolution Revolution about a horizontal axis perpendicular to the frontal plane Revolution about a vertical axis perpendicular to the horizontal plane	Practical applications of revolutions	Clear plastic projection plane Hinged, plastic box Chart: 130
	Revolution about a vertical axis perpendicular to the profile plane Direction of the revolution Successive or multiple revolution Finding the true length of line by revolution		
Pattern development	Descriptive statement	Use in solving geometrical problems Industrial application of developments and intersections	Field trips to sheetmetal and heating shops, oil and copper refineries, and sugar mills
Parallel line development	Development of right, truncated, and oblique prisms Development of right, truncated and oblique cylinders	Relationship to the study of graphics	Paper patterns of developments and intersections Metal patterns Films: 79, 109
Radial line development	Right and truncated pyramids Right and truncated cones		Transparency: 126
Triangulation	Development of oblique pyramids, cones and transition pieces		
Intersections	Square and rectangular prisms Cylinders Oblique intersection of cylinders Prisms and pyramids Cones and cylinders		Films: 87, 94

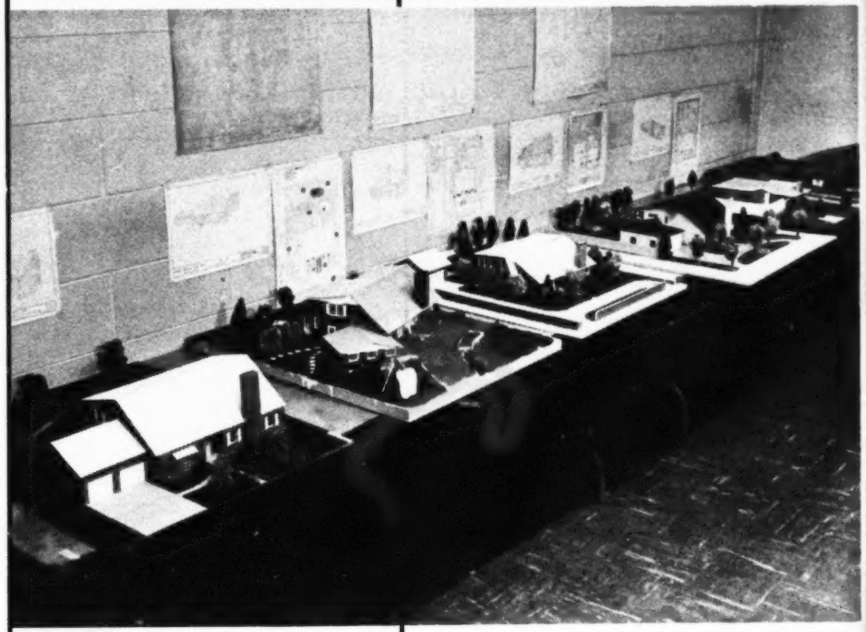
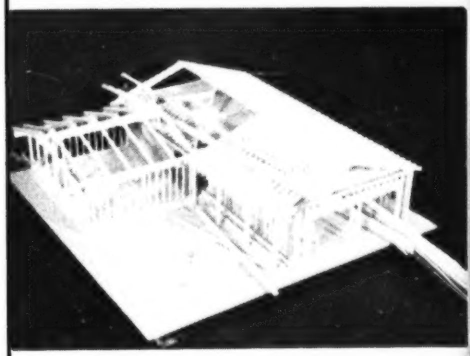
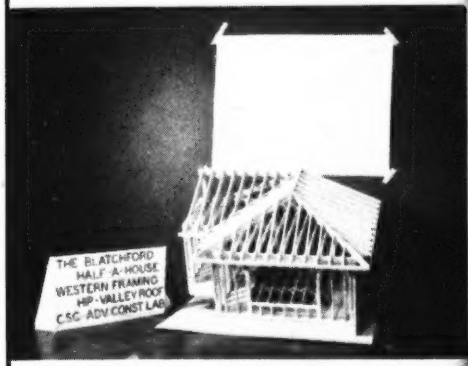
Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Tracing	Pencil tracings Ink tracings	Use and importance Storage Use of microfilm in industry	Film: 86 Tracing paper Tracing cloth Tracing film Inking pens
Reproductions	Available methods and processes Care and maintenance of materials and equipment	Advantages of: a. Mechanical processes b. Photochemical processes c. Special processes	Materials used in the various processes for reproducing drawings

ADVANCED MECHANICAL DRAFTING

Since we live in an industrial age, and mechanical drafting is the universal language of industry, these units of instruction meet the needs and abilities of all students in the secondary schools. The instructor would select, from the areas outlined, units of study based on the needs and interests of the individual student.

The prerequisite for this course is basic mechanical drafting.

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Aircraft	Plans Profiles Design layouts Details Working drawings Production illustration Templates Symbols Lettering and dimensioning		Field trips Models Mock-ups Flexible curves Films: 79, 87, 94, 109
Architectural Details of construction	Foundation, sill, wall and cornice in frame, brick veneer and solid masonry construction Door and window sections in frame, brick veneer and solid masonry construction Joist, trimmer, and girder construction Roof framing Stair construction Fireplace construction Symbols of materials in section	Materials of construction Comparative cost of frame, brick veneer and solid masonry construction City building codes Zoning regulations Contracts F. H. A. building codes	Field trips Films: 66, 76, 99, 115 Models Material samples
Plans	Floor plans a. Room arrangement b. Standard practices for dimensions and notes c. Window schedules d. Door schedules e. Electrical symbols f. Fixture symbols Elevations a. Front b. Rear c. Right side d. Left side e. Surface symbols f. Standard dimensions and notes	Standard window and door sizes Furniture and fixture sizes Specification sheets Climate Soil structure	Commercial house plans Films: 47, 84, 96, 111

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	Pictorial a. Steps in the development of a 2-point perspective b. Color Foundation and basement plans Kitchen detail Other details Plot plan Model construction		Model construction materials Film: 93   THE BLATCHFORD HALF-A-HOUSE WESTERN FRAMING HIP-VALLEY ROOF CSC ADV CONST LAB
Charts and Graphs	Types of charts a. Rectangular b. Logarithmic c. Similogarithmic d. Composite e. Bar	Relation to technical and financial problems Conveyance of information to the public Showing trends Use to the engineer	Enlarged charts and graphs

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	f. Area g. Circular h. Polar i. Trilinear j. Organization k. Nomographs l. Pictographs	and technician Use to the mathematician	
Electrical	Symbols Single line diagrams Schematic diagrams Use of templates for conventional symbols Use of scale Letter symbols	City building code requirements	Templates Chart: 135
Graphics	Review and practical application of: Orthographic projection a. Points b. Lines c. Planes d. Solids	Relationship to the fields of science and engineering	Plastic, hinged box Clear plastic projection plane Dowel rod Welding rod Films: 72, 73, 103 Chart: 130
	Visibility Pictorial drawings a. Axonometric b. Oblique c. Perspective Spatial geometry a. Points and lines b. Lines and planes Plane and curved surfaces Surface and solid intersections Developments		
Machine Screw threads	Nomenclature Forms a. Symbols b. External c. Internal	Fasteners a. Bolts and nuts b. Screws c. Keys d. Rivets Helix	Models Chart: 136 Films: 67, 83, 100, 106 Samples Transparency: 119
Cams	Uses Kinds Kinds of motion	Practical application	Samples

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Gears	Nomenclature Kinds Steps	Involutes	Samples Models
Patent	Complete illustrations Strict requirements Uniform standards of execution and excellence Character of lines Cross-hatching and shading Arrangement of views Reference character Figure for official gazette Transmission of drawings Extraneous matter Symbols and legends	Procedures of patent	Patent drawings
Production illustration	Pictorial drawing a. Isometric b. Oblique c. Cabinet Exploded views Orthographic projection Rendering a. Line shading b. Stippling c. Smudge	Use in production lines Use in parts catalog Use in maintenance	Catalogs Craftint paper Film: 114
Structural	Structural steel shapes Symbols of structural steel shapes Rivets and bolts Welding symbols Reinforced concrete Brick structures Structural woods	Simple stress and strain Pre-stressed concrete	Field trips Films: 68, 92

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Topographic	Definitions: a. Atlas b. Plat c. Plan d. Profile e. Contour Lines, intervals, and control points	Occupational opportunities	Aeronautical charts Field trips to the Reclamation Bureau and department of Geographical Survey
Welding	Basic symbols of gas and arc welds Supplementary symbols Weld dimensioning	Basic weld joints Basic gas and arc welds	Illustrations Models Chart: 131

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22. Harris, Charles O. *Elementary Structural Design.* Chicago: American Technical Society, 1951

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* Suggested texts.

23. Hobart. *Modern Architectural Welding*. Troy, Ohio: Hobart Trade Schools.

24. Hood, G. J., and Palmerlee, A. S. *Geometry of Engineering Drawing*. New York: McGraw-Hill Book Co., 1956.

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66. *"A" is for Architecture,* 30 minutes, color, Audio-Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

67. *According to Plan,* 9 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 st., New York 36, New York.

68. *The Arch Bridge,* 29½ minutes, United States Steel Film Distribution Center, Columbia Geneva Steel Division, 120 Montgomery Street, San Francisco, California.

69. *Auxiliary Views,* 11 minutes, silent (work sheets, ½¢ each), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

70. *Auxiliary Views,* Part 1, 11 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

71. *Auxiliary Views,* Part 2, 10 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

72. *Auxiliary Views, Double Auxiliaries,* 13 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

73. *Auxiliary Views, Single Auxiliaries,* 23 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

74. *Behind the Shop Drawing,* 22 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

75. *Body Bountiful,* 25 minutes, General Motors Corporation, 508 United California Bank Building, 405 Montgomery St., San Francisco 4, California.

76. *Building for the Nation,* 28 minutes, United States Steel Film Distribution Center, Columbia Geneva Steel Division, 120 Montgomery Street, San Francisco, California.

77. *Capital Letters,* 21 minutes (work sheets, ½¢ each), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

78. *Concept and Principles of Functional Drafting,* 20 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

79. *Development of Surfaces,* 11 minutes, silent (work sheets ½¢ each), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

80. *Drawings and the Shop,* 15 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

81. *Drafting Tips,* 28 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

82. *Draftsman,* 11 minutes, Carl Mahnke Productions, Des Moines, Iowa.

83. *Engineering,* 11 minutes, Carl Mahnke Productions, Des Moines, Iowa.

84. *Frank Lloyd Wright,* 30 minutes, Audio Visual Aids Library, Pennsyvania State University, University Park, Pennsylvania.

85. *Freehand Drafting,* 15 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

86. *Ink Work and Tracing,* 16 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

87. *Intersection of Surfaces,* 11 minutes, silent (work sheets), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

88. *Language of Drawing,* 10 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

89. *Lettering Instructional Materials,* 22 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

90. *Lever-Age,* 21 minutes, Shell Oil Company, 624 S. Michigan Ave., Chicago, Illoinis.

91. *Lower Case Letters,* 18 minutes (work sheets), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

92. *Mackinac Bridge Diary,* 27 minutes, United States Film Distribution Center, Columbia Geneva Steel Division, 120 Montgomery Street, San Francisco, California.

93. *Make a House Model,* 11 minutes, color, Bailey Film, Inc., 65 DeLongpre Ave., Hollywood 28, California.

94. *Oblique Cones and Transition Development,* 11 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

95. *Orthographic Projection,* 18 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

96. *Perspective Drawing,* 8 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

97. *Pictorial Drawing,* 30 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

98. *Pictorial Sketching,* 11 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

99. *Portrait of a City, Detroit,* 26 minutes, color, Film Library, Ford Motor Company, 4303 Telegraph, Oakland 9, California.

100. *Principal Dimensions, Reference Surfaces and Tolerances,* 12 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

101. *Sectional Views and Projections, Finish Marks,* 15 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

102. *Sections,* 10 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

103. *Sections and Conventions,* 15 minutes, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

104. *Selection of Dimensions,* 18 minutes, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

105. *Shape Description I,* 11 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

106. *Shape Description II,* 8 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

107. *Shop Drawings,* 22 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

108. *Shop Procedures,* 17 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

109. *Simple Developments,* 11 minutes, McGraw-Hill Text Films Department, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

110. *Size Description,* 13 minutes, McGraw-Hill Book Company, Inc., 330 West 42 Street, New York 36, New York.

111. *Space,* 10 minutes, color, Bailey Film Inc., 65 DeLongpre Ave., Hollywood 28, California.

112. *Teaching Drafting with Transparencies,* 9 minutes, Audio Visual Aids Library, Pennsylvania State University, University of Pennsylvania.

113. *A Thing of Beauty,* 16 minutes, General Motors Corporation, 508 United California Bank Building, 405 Montgomery Street, San Francisco 4, California.

114. *Three Dimensional Drawing,* L. L. Ridgeway Company, Inc., 1522 Glenarm Place, Denver, Colorado.

115. *Tomorrow Meets Today,* 25 minutes color, Film Library, Ford Motor Company, 4303 Telegraph, Oakland 9, California.

116. *Use of a T-Square and Triangles,* 11 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

117. *Why Study Industrial Arts,* Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

Other Resource Materials

Transparencies

118. *Auxiliary Views* (8 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

119. *Bolts and Screws* (11 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

120. *Dimensioning* (10 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

121. *Graphic Solutions* (19 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

122. *Orthographic Projection* (5 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

123. *Pictorial Drawing* (11 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

124. *RCA Overhead Transparencies for Mechanical Drafting, Parts I & II,* RCA Educational Services, RCA Service Company, A Division of Radio Corporation of America, 204-2 Cherry Hill Offices, Camden 8, New Jersey.

125. *Sectional Views* (6 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

126. *Sheet Metal Layout* (11 transparencies), McGraw-Hill Text Film Department, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York.

Charts

127. *Alphabet of Lines Chart,* Eugene Dietzgen Company, Chicago, Illinois.

128. *Decimal Equivalent Chart,*
    Eugene Dietzgen Company, Chicago, Illinois;
    Frederick Post Company, Chicago, Illinois;
    Keuffel & Esser Company, 145 Yuma Street, Denver 23, Colorado;
    Lufkin Rule Company, Saginaw, Michigan;
    L. L. Ridgway, 1522 Glenarm Place, Denver 2, Colorado.

129. *Dimensioning Chart,* Frederick Post Company, Chicago, Illinois.

130. *Geometry of Engineering Drawing Chart,* University of Kansas, Lawrence, Kansas.

131. *Hobert Welding Information Chart,* Hobart Brothers Company, Troy, Ohio.

132. *Lettering Chart,* Frederick Post Company, Chicago, Illinois.

133. *Lettering Guide Chart for Drafting Room,* Eugene Dietzgen Company, Chicago, Illinois.

134. *Lettering Guide Chart for T-Squares,* Eugene Dietzgen Company, Chicago, Illinois.

135. *Symbols,* Eberhard-Faber, Wilkes-Barre, Pennsylvania.

136. *Unified and American Screw Threads for Screws, Bolts, Nuts and Other Threaded Parts,* American Standards Association.

Catalogs

137. Alvin & Company, Windsor, Connecticut.

138. Charles Bruning Company, Inc., 2484 W. 2nd Ave., Denver, Colorado.

139. Eugene Dietzgen Company of Colorado, 3875 Elm, Denver, Colorado.

140. Keuffel & Esser Co., 145 Yuma Street, Denver 23, Colorado.

141. A. Lietz Company, San Francisco, California.

142. Frederick Post Company, Chicago, Illinois.

143. L. L. Ridgway Company, Inc., 1522 Glenarm Place, Denver, Colorado.

144. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

145. Universal Drafting Machine Corporation, Cleveland, Ohio.

146. V & E Manufacturing Company, Pasadena 20, California.

METALS

Mack Hoover

CHAPTER XIV

GENERAL METALS

More people are employed in the field of metalwork and more products are produced here than in any other industrial field. One out of every ten workers is employed in some area of metalwork. The skills vary greatly, from the unskilled helper to the master technician. The space age will become more dependent upon the metal-working industry to lead the way in the development of better methods and materials. Research in the development of alloys capable of withstanding tremendous heat is an example. More technicians and skilled workmen are needed. The industrial arts departments of the state can do their part to ignite the spark of interest within their students.

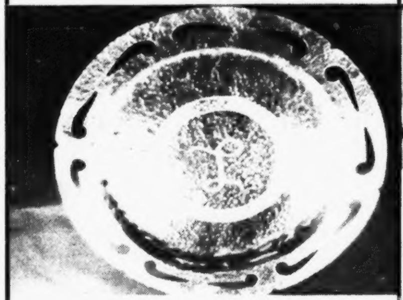
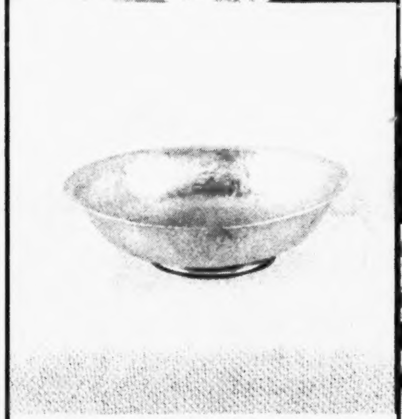
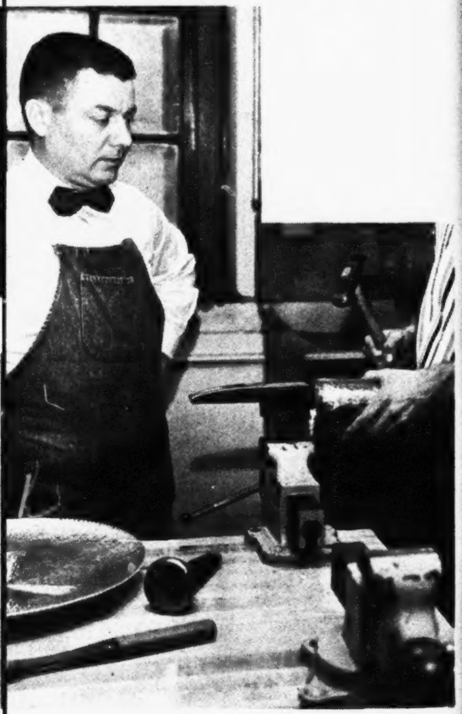
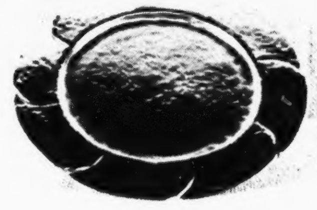
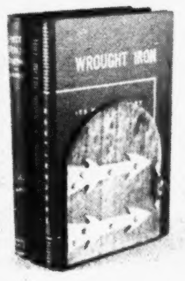
The scope of the general metals program will vary depending upon the size of the school, and the space and equipment available. An ideal program should include sheetmetal, foundry, forging, bench metal, art metal, machine shop, arc and gas welding. Sheetmetal, art metal, and bench metal are the areas that usually are taught in the junior high school. Every school should attempt to offer some of the areas if it is impossible to offer all of them. The areas within this guide are developed to include all of the basic processes, thereby allowing the school a choice of teaching part or all of the processes.

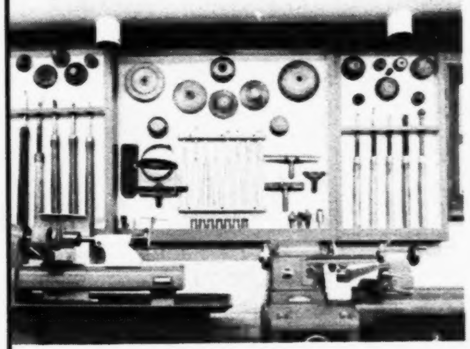
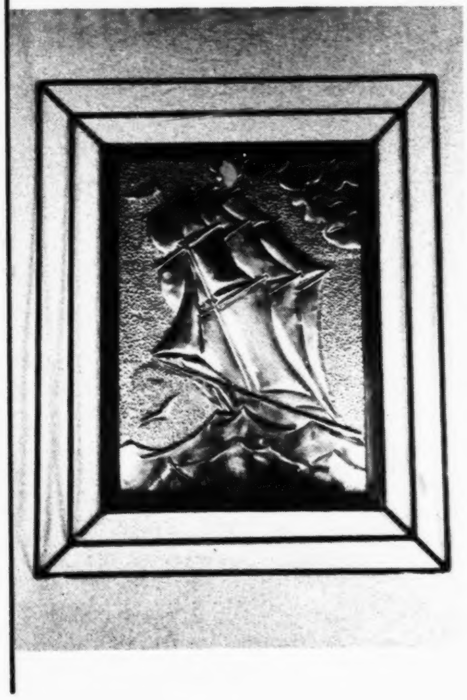
ART METAL

Art metal is concerned with the shaping and forming of non-ferrous metals. The purpose of teaching this area in the Colorado schools is to develop an appreciation of fine craftsmanship, an understanding of the properties of non-ferrous metals, and an avenue of self-expression.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Select and plan a project	Design (Consider function, form, durability, color, construction)	Non-ferrous metals, types and gauges	**Film: 107
*Make out a bill for material	Cost computation ☆ Safety		Film: 102
*Development and layout	Development of fundamentals	Development of techniques.	Film: 89 Film: 84 Film: 93
*Cutting and filing	Use of shears, hacksaw, jewelers saw, and files	Types of shears, snips, saws, saw blades, and files	Pamphlet: 146

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Forming	Shallow forming, high raising, annealing, pickling, and use of forming tools	Types of forming tools  	Equipment catalog: 142 
*Assembling	Soft and hard soldering, riveting, and metal screws	Types of solder, flux, rivets, and screws	Pamphlet: 144
*Drilling	Hand and machine	Types of drills and care	Film: 110 Charts: 133, 134, 135
*Surface Decoration	Planishing, peening, overlaying, piercing, coloring, etching, fluting, doming, scalloping, engraving, chasing, tooling, stippling, repousing, enameling, and electroplating	Etching materials, decorative, tools, types of color finishes, and principles of electroplating 	Samples of decorative pieces 

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Finishing	Polishing and protective coating	Types of polishing abrasives and compounds. Types of finishes	Film: 96 Film: 83 Chart: 82
*Spinning	Care and maintenance Set-up, centering, break-down, shallow spinning, deep spinning, sectional chuck spinning, spinning on air, trimming, edging and finishing	Lubricants Shape allowances Speeds and tools Types of finishes Mass production methods Occupational information	Sample finishes Film: 104 "Occupational Outlook Handbook" 149 
*Metal tooling	Transfer pattern, interline, raise or emboss metal and finish		

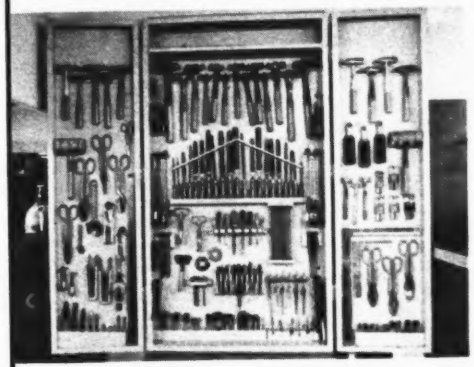
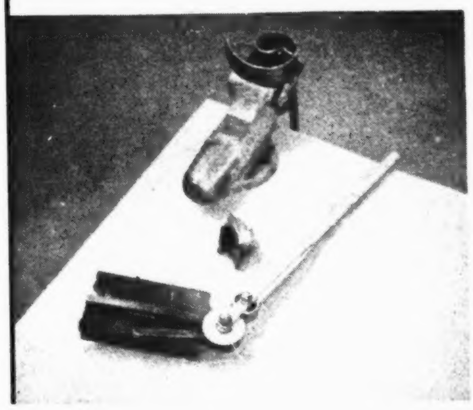
Suggested projects — Art Metal:

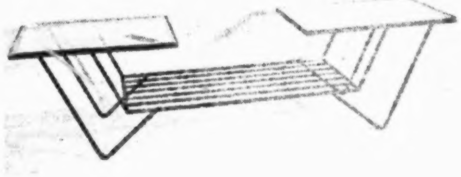
Ash tray
Candy dish
Fruit bowl
Belt buckle
Coaster
Candle holders
Serving tray
Tooled picture
Vase
Book ends

BENCH METAL

Bench metal includes such basic operations as layout, cutting, forming, drilling, threading, riveting, and assembling. These operations are basic to advanced areas of metalwork. Mild steel is most commonly used, but copper, brass, aluminum or other materials may be used.

Emphasis is placed on understanding industry by working with these various metals and studying their industrial uses. These metals are used in architecture and furnishings of modern construction and manufacturing.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Select and plan a project	Design (Consider function, form, durability, color, construction)	Types of metals and their characteristics for shaping Selection of material	**Film: 98 Film: 106 Chart: 131
*Make out a bill for material	Cost computation ☆ Safety	Manufacturing	
*Development and layout	Layout tools	History of measurement	Chart: 132
*Cutting	Use of the hand and power hacksaw, cold chisel shears, files, bolt cutters, and thread cutting Use of the grinder	Cutting lubricants Selection and kinds of hacksaw blades Types of chisels, files, grinders, and grinding wheels Uniform thread standards	Pamphlet: 146 Pamphlet: 147 Film: 88 Chart: 136 
*Forming metal	Use of vises, forming machines, hand bending, hot and cold forming, twisting, and the use of hammers	Bend allowances Types of bending machines Bending jigs Methods of heating Types of hammers	Book: 44a 



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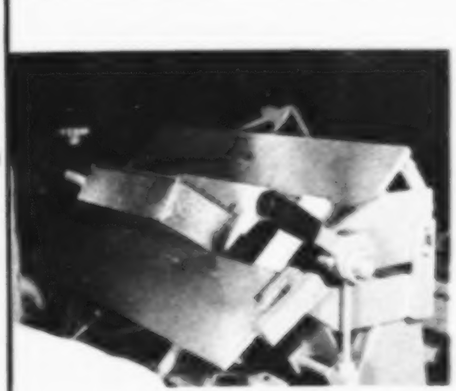
*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
			
*Drilling	Methods of drilling Use of machines Countersinking Center punching	Size and kinds of drills Cutting speeds	Charts: 133, 134, 135 Film: 110
*Assembling	Use of rivets, bolts, screws, welding, brazing, resistance welding, and holding jigs	Kind and size of rivets, bolts, and screws Welding processes 	
*Finishing	Use of abrasives, surface decoration, spot finishes, heat coloring, chemical coloring, plating, paints and fillers, peening and polishing	Kind and types of abrasives, paints and chemicals Occupational information	Film: 82 Chart: 121 "Occupational Outlook Handbook" 148 Film: 97

Suggested projects — Bench Metal:

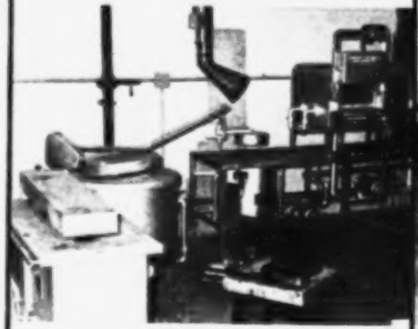
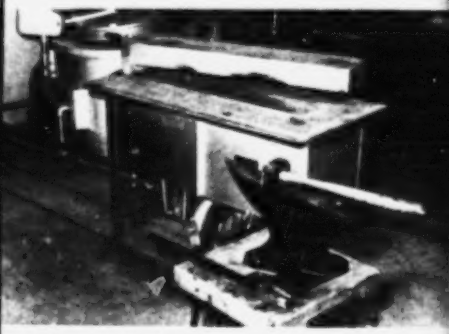
- Book ends
- Address holder
- Wall lamp
- Plant hanger
- Serving tray
- Book rack
- Shelf bracket
- Tie rack
- Candelabra
- Fireplace tools
- Magazine rack
- Coffee table
- End tables
- Record rack
- Lamp post
- Desk
- Table and chairs

FORGING

The purpose of teaching a unit in forging is to acquaint the students with the processes involved in in forming and shaping of hot metals, cold metals, heat treatment of steel and forging in modern industry.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Select and plan a project	Design (Consider function)	Metals used in forging and their manufacture	Finished project Sequential operations plan **Film: 106
*Make out a bill for material	Cost computation ☆ Safety		Film: 92
*Operate a gas or coal forge	Temperature control	Types of forges and fuels	Film: 79
*Drawing out metal	Proper heat Proper use of hammers, anvils, tongs, swages	Types and sizes of hammers, tongs, swages, anvils	Finished projects Sequential operations plan
*Shaping and forming	Bending, twisting, upsetting	Principles of forge welding	Finished projects Sequential operations, plan
*Cutting and punching	Harden, hot punch, cold punch, hot chisel, cold chisel	Cutting and punching tools	Sequential operations plan

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Heat treating	Annealing, hardening, surface hardening, tempering	Heat range determined by color Hardening compounds, annealing and tempering techniques, hardness testing 	Sequential operations plan Film: 90 Film: 91 Pamphlet: 152 Pamphlet: 151 
*Finishing	Grinding, filing, hammer finishing	Abrasives, files Finishes and methods of finishing Industrial forging Occupational information	Pamphlet: 146 "Occupational Outlook Handbook" 148

Projects — Forging:

Projects from high carbon steel

Cold chisel
Pin punch
Center punch
Drift punch
Wrecking bar
Screwdrivers

Projects from medium carbon steel

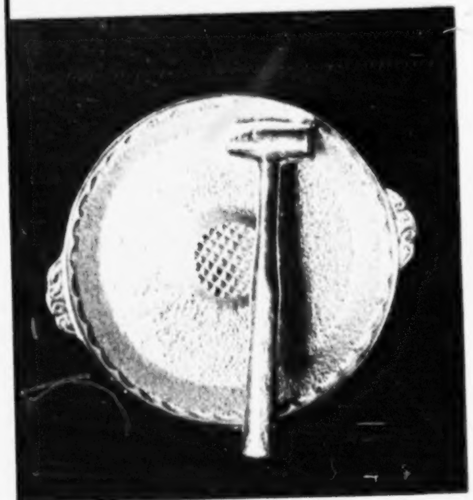
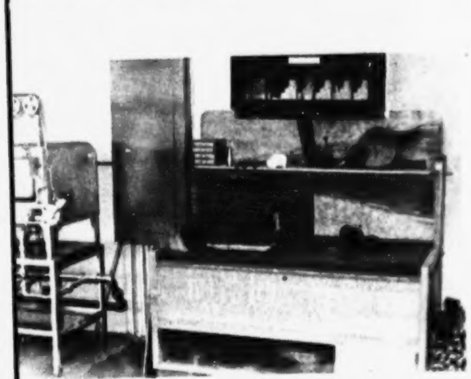
Screwdrivers
Hammers
Sledges
Wrecking bar

Projects from low carbon steel

Toasting forks
Forgings
Foot scraper
Tent stakes

FOUNDRY

Foundry work is concerned with the melting and pouring of metals into molds to form castings. Pattern making should be taught in conjunction with foundry in the schools offering this area of learning. The purpose of teaching a unit in foundry in our modern schools is to acquaint the students with the practice of casting and also to give the student an understanding and appreciation of machining parts and other casting. As a part of the general metals course, aluminum casting seems to be the most practical method of teaching foundry.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Select and plan a project	Design (Consider form, function, durability, finish,, and suitability of casting)	Types of metals and alloys	**Finished projects Pamphlet: 138 
*Make out a bill for material	Cost computation ☆ Safety		Sample plan
*Patternmaking	Design, draft, materials, and shrinkage	Care of equipment Kinds of patterns	Chart Pattern development 
*Cut and temper sand	Test sand	Kinds of sand for molding and cores Binders	Film: 95

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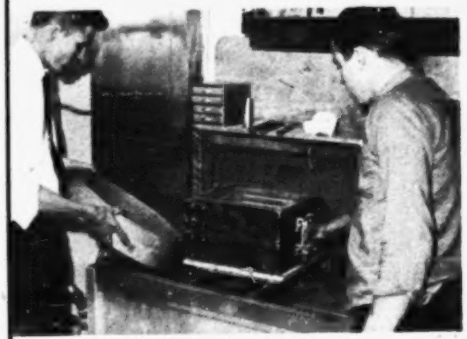
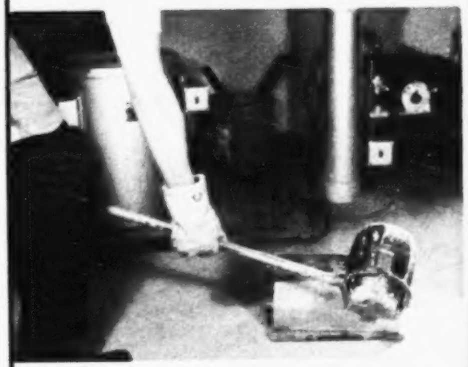
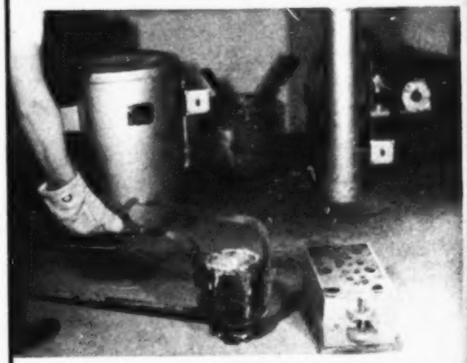
*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Preparing the mold	Pattern placement, ramming a drag, vent, parting compound, use of turning board, ramming the cope, locating sprue and riser holes, cutting gates, removing pattern, patch mold, and using molding tools	Types of flasks, parting compounds, and tools	Film: 99 
*Core making	Baked cores CO^2 cores		Film: 75
*Pouring the mold	Use and kinds of protective clothing and equipment Pouring temperatures Fluxing and skimming metal Floor preparation Pouring and cooling the metal	Types of furnaces and fluxes	 
*Removing, cleaning and finishing	Shake out, cut gates, clean casting, file, sand, polish, paint, and special finishes and reflecting beads	Types of files Finishes Polishing Compounds and abrasives Mass production methods Occupational information	Chart: 129 Sample finishes Film: 85 Chart: 120 "Occupational Outlook Handbook" 148

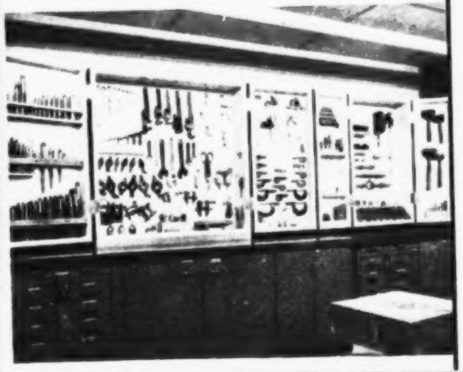
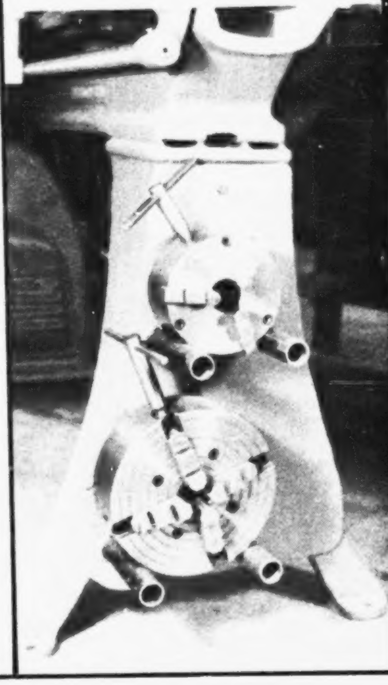
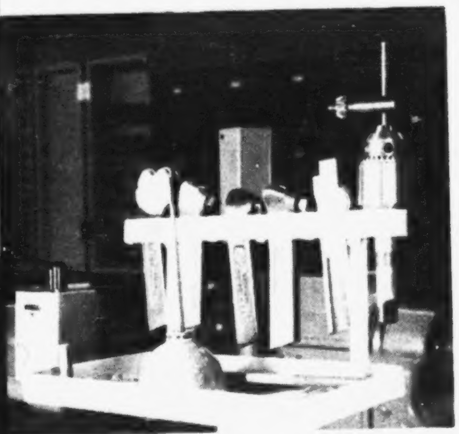
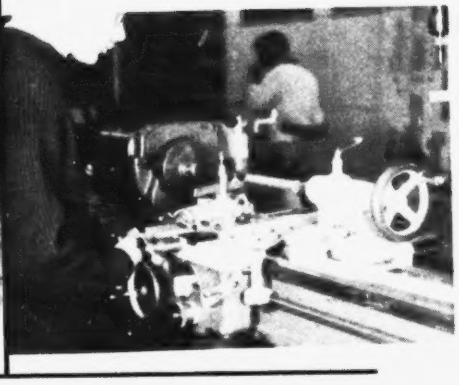
Suggested projects — Foundry:

The beginning students should select a project such as a paper weight, book ends, plaque, or other one-piece casting. Cored or sectioned castings may be purchased from local stores but it is best to encourage the students to develop their own patterns.

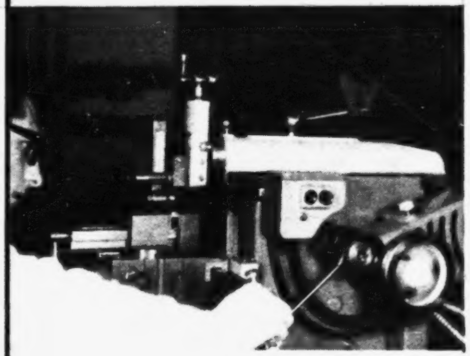
More advanced foundry programs can be developed around a more complex project that includes other areas such as machine shop.

MACHINE SHOP

In machine work the basic power tools used in industry should be taught. The purpose is to acquaint students with these basic machines, to help students discover aptitudes and interests in this area, and to develop an understanding and appreciation of modern industry.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Select and plan a project	Design and blueprint reading	Metals and their alloys Ferrous and non-ferrous metals	**Pamphlet: 149 Film: 98
*Make out a bill for material	Cost computation ☆ Safety	Suitable materials	Film: 106 Flow chart: 149 Sample projects
*Development and layout	Uses of layout, tools, and materials	Types of measuring tools	Film: 105
*Use of the engine lathe 	Care and maintenance Uses of chucks, drills, mounting work between centers, calipers, facing, tapering, knurling, boring, threading, filing, polishing, steady rest, follower rest, center rest, cutting tools, and coolants Grinding cutter bits (Selection of units influenced by grade, level, time, and equipment)	Principle parts of the lathe Speeds and feeds Special attachments such as milling and grinding attachments Types and sizes of cutter bits Types of coolants 	Film: 103 Film: 87 Sequence of processes chart  

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Use of drilling machines	Care and maintenance Uses of drill presses and portable drills Adjusting speeds and feeds Use of coolants Boring, reaming and tapping	Types of drilling machines, taps, reamers, and boring tools Drilling speeds and feeds Clamping fixtures and tools	Charts: 133, 134, 135 Film: 110 Chart: 136
*Use of the shaper	Care and maintenance Setting up work, clamping, adjusting stroke, feed, speeds, and bit grinding Cutting keyways, vertical cuts, angular cuts, irregular cuts Tees, vees, and dovetails	Types of shapers Types and sizes of cutter bits Coolants Special set-ups	Film: 78 
*Use of the milling machine	Care and maintenance Set-up and use of the milling machine and attachments such as the index head and vertical mill attachment Methods of fastening work for milling Adjusting feeds and speeds Cutting keyways, grooves, flutes, slots, gears, angular surfaces, gang milling, and end milling	Types of milling machines, cutter gears, coolants Special set-ups such as indexing, clamping, fixtures and tools Feeds and speeds	Film: 77 Film: 76 Pamphlet: 143
*Use of grinders	Care and maintenance Use of tool grinders, surface grinders, cutter grinders, and portable grinders Adjusting feeds and speeds	Types of grinding abrasives, grades, bonds, and speeds Types of grinding machines Feeds and speeds Special set-ups Coolants	Film: 86 Chart: 137 Film: 88 Film: 108 Chart: 121

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Use of power saws	Care and maintenance Use of hacksaws, bandsaws, and cuttoff wheels Straight, angular, and contour sawing Filing and polishing Clamping devices	Types of hacksaws, bandsaws Abrasive and friction saws Feeds and speeds Saw blades Coolants	
*Heat treating	Use of furnaces for heat treatment Annealing, hardening, and tempering Temperatures and color	Classification of steel Types of heat treating furnaces Quenching processes Critical temperatures Flame hardness testing Occupational information Mass production methods	☆Film: 90 Film: 91 Pamphlet: 152 Pamphlet: 151 Film: 94 "Occupation Outlook Handbook" 148

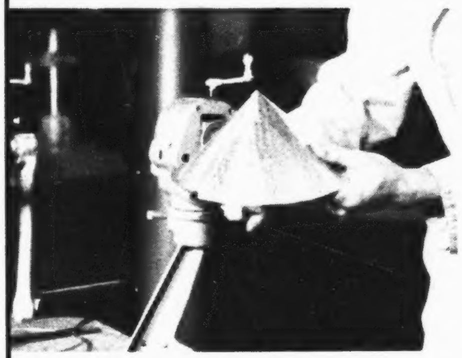
Suggested projects — Machine Shop:

Punch
Screwdriver
"C"clamp
Handy vise
Cutting threads
Cutting gears
Drill press

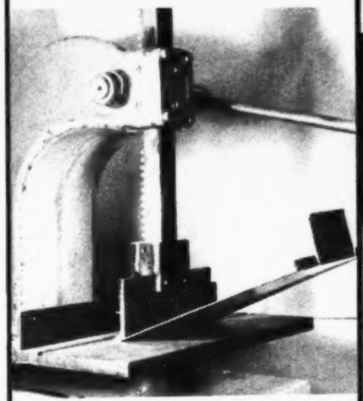
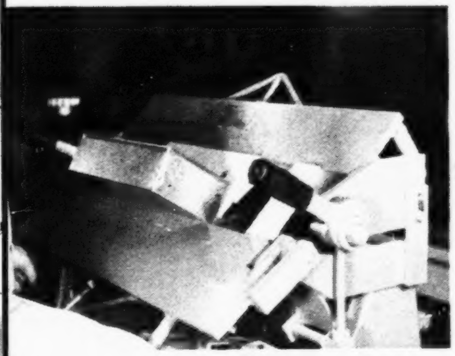
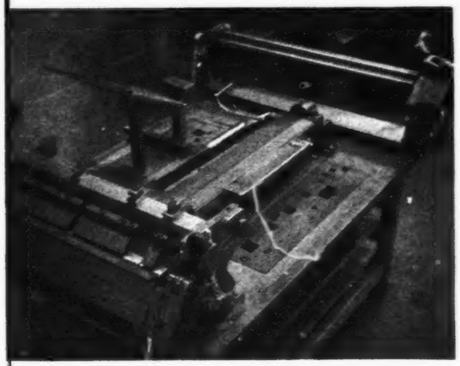
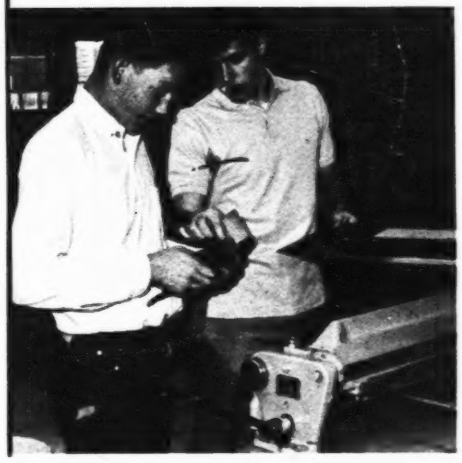
Drill press vise
Anvil
Surface gauge
Tap wrench
Weights
Grinder
Stand for portable drill

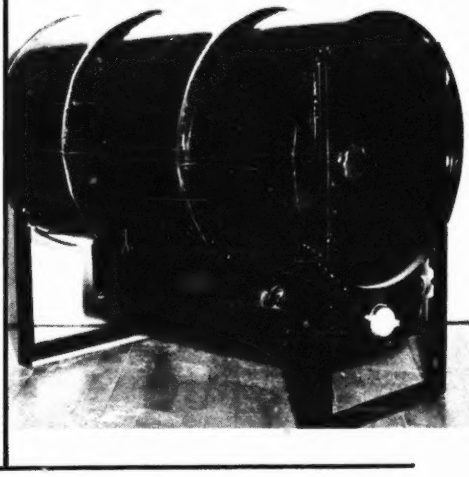
SHEET METAL

Sheet metal has many applications ranging from heating, ventilation, and automobiles to small items found in the home. The unit in sheet metal should give the students an insight into the many phases of the industry. Sheet metal instruction can be a valuable part of any industrial arts program by developing basic skills such as reading a drawing, accuracy in planning, layout, cutting, shaping, and assembling.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Select and plan a project	Design (Consider form, function, durability, finish, and suitability)	Ferrous and non-ferrous metals Types and gauges	**Pamphlet: 150 Pamphlet: 149 Film: 106 Film: 98
*Make out a bill for materials	Cost computation ☆ Safety		
*Development and layout	Parallel line development Radial line development Triangulation	Techniques of development	Charts and samples (Instructor-made) 
*Cutting sheet metal	Shearing Use of hand snips Use of cold chisels Filing	Types of shears Types of snips Types of chisels Types of files	Film: 74 Chart: 122 Pamphlet: 146 Pamphlet: 141

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Bending sheet metal	Use of brakes and folder Hand bending	Types of bending equipment Bend allowances 	Equipment catalogs Machinery's Handbook, 44a 
*Forming sheet metal	Roll forming Hand forming	Types of turning equipment	Equipment catalogs 
*Drilling sheet metal	Hand and machine	Twist drills	Charts: 133, 134, 135 Pamphlet: 140
*Punching sheet metal	Hand and machine	Types of punching equipment	Equipment and tool catalogs
*Fastening	Seams and joints 	Kinds and sizes of fasteners Types of solders and fluxes Welding processes	

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Finishing edges	Hemming and wiring	Bend allowances	Machinery's Handbook 44a
*Finishing	Preparing and painting	Paints and cleaners	Metal finishes: 123, 124 "Occupational Outlook Handbook" 148 

Suggested projects — Sheet Metal:

- Cookie cutter
- Scoop
- Letterholder
- Napkin holder
- Ash tray
- Serving
- Tool tray
- Baking pan
- Measure can
- Funnel
- Planter
- Bed lamp
- Patio lamp
- Wastebasket
- House number
- Picture frame
- Wall shelf
- Tool box
- Mailbox
- Magazine rack

WELDING

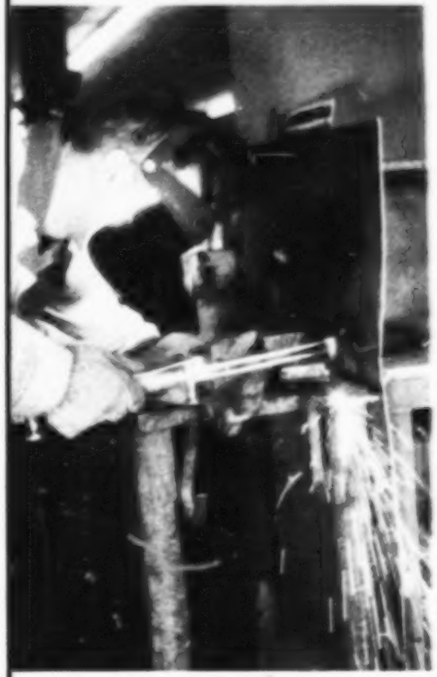
Welding is concerned with the melting and fastening together of metals by the use of heat. The purpose of teaching gas and electric welding is to expose the students to related information and practices in the art of welding. Whether it is used in a large industrial plant, a small job shop, or for personal use, welding is a valuable and an indispensible part of any general metals program.

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
*Assembling the equipment	☆ Safety Care and maintenance of equipment	Equipment nomenclature Protective equipment	**Charts on equipment
*Adjusting the equipment	Regulator settings Lighting, adjusting and turning off the torch Tip cleaning	Tank sizes and pressures Cylinder content and construction Acetylene generator	Catalogs on equipment Film: 113 Chart: 130
*Flat welding	Joint preparation, rodless, rod, fillet, butt, lap and jigs	Types and sizes of rod, ferrous and non-ferrous, and fluxes	Film: 81 Sample Welds
Position welding	Horizontal, vertical and overhead welding	Temperature control	Film strip "Fundamental Equipment" 114 "Learn to Run a Bead" 118 "How to Make Welds" 117 "Welding Cast Iron" 119 "Hardsurfacing" 115 "Heating and Cutting" 116
*Brazing and hard soldering	Low-temperature rods	Metal characteristics Fluxes and temperatures	Film: 100

*Identifies areas applicable to general shop.

**Check reference numbers at end of unit.

☆ Safety included in all operations—refer to Safety Unit, Chapter V

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Special welding processes	Cast iron, aluminum, pot metal, copper, and brass	Fluxes and special methods	Film: 109 Film: 111
*Cutting processes	Equipment, assembly, adjustment	Iron powder cutting Underwater cutting	
Controlling and correcting distortion	Clamping, peening, heating, presetting, and tack welding	Occupational information History of gas welding	"Occupational Outlook Handbook" 148 Pamphlet: 139
ARC WELDING			
Machine set-up	Amperage and voltage setting Polarity	Types of machines Protective equipment	Equipment Catalogs 145, 147

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Striking the arc	Arc length and electrode angle	Types, sizes, and coating of electrodes A.W.S. and A.S.T.M. standards	Charts: 126, 127, 128 Film: 101 Film: 112
*Flat welding	Butt, lap and fillet Electrode position and manipulation	Electrode choice	Sample welds
Position welding	Horizontal, vertical and overhead welding Electrode position and manipulation		Sample welds
Special welding	Carbon arc, inert gas, non-ferrous, cast iron, hard-surfacing and cutting Spot welding	Types of electrodes Occupational information	Charts: 126, 127, 128 Sample welds "Occupational Outlook Handbook" 148 Pamphlet: 139

Welding can be taught best by the use of various exercises. Examples of these are: running beads, flat, vertical, horizontal, and overhead.

Suggested projects — Welding

Vise	Jack stands
Basketball goal	Furniture

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Films and Filmstrips

Film ordering key information:

ARSC — Air Reduction Sales Co., 205 West Monroe St., Chicago 6, Ill.

ACA — Aluminum Company of America, 818 Alcoa Bldg., Pittsburgh, Pa.

ADMC — Archer Daniels Midland Co., Foundry Products Div., 2191 West 110th Street, Cleveland 2, Ohio.

CTDC — Cleveland Twist Drill Co., 650 Howard Street, San Francisco 5, Calif.

CFI — Colorado Fuel and Iron Corporation, P. O. Box 1920, Denver 1, Colorado.

CSC — Colorado State College, Instructional Materials Center (Attention: Booking Clerk), Greeley, Colo.

CSU — Colorado State University, Audiovisual Center (Attention: Booking Clerk), Fort Collins, Colo.

CU — Colorado University, Bureau of Audiovisual Instruction (Attention: Booking Clerk), Boulder, Colo.

C — Cromars, 922 Bannock Street, Denver 4, Colo.

DAC — Do-All Company, 254 North Laurel Avenue, Des Plaines, Ill.

EWA — Eutectic Welding Alloys Corporation, Flushing, New York.

FGSC — Fellows Gear Shaper Co., Publicity Dept., Springfield, Vermont.

GMC — General Motors Corporation, 405 Montgomery Street, San Francisco 4, California.

HH — Handy and Harman, 850 Third Avenue, New York 22, New York.

IU — Indiana University, Material Instruction Center (Attention: Booking Clerk), Bloomington, Ill.

LEC — Lincoln Electric Co., Box 3115, Cleveland 17, Ohio.

NC — Norton Company, Publicity Dept., Worchester 6, Mass.

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101. *Prevention and Control of Distortion in Arc Welding*, LEC.
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103. *Rough Turning Between Centers*, SBLC.
104. *Spinning*, ACA.
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106. *Steel's Party Line*, CFI.
107. *Story of Copper*, CU.
108. *Techniques of Surface Grinding*, DAC.
109. *Torch Welding*, ACA.
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111. *Welding Advances in Aluminum*, ACA.

112. *Welding Comes to the Farm,* LEC.

113. *Whatever We Do,* ARSC.

Filmstrips:

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115. *Hardsurfacing,* LEC.

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117. *How to Make Welds,* LEC.

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Other Resource Materials

Charts:

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121. *Coated Abrasives,* Norton Company, Publicity Department, Worchester 6, Mass.

122. *Cold Chisels,* Stanley Tool Co., New Britain, Connecticut.

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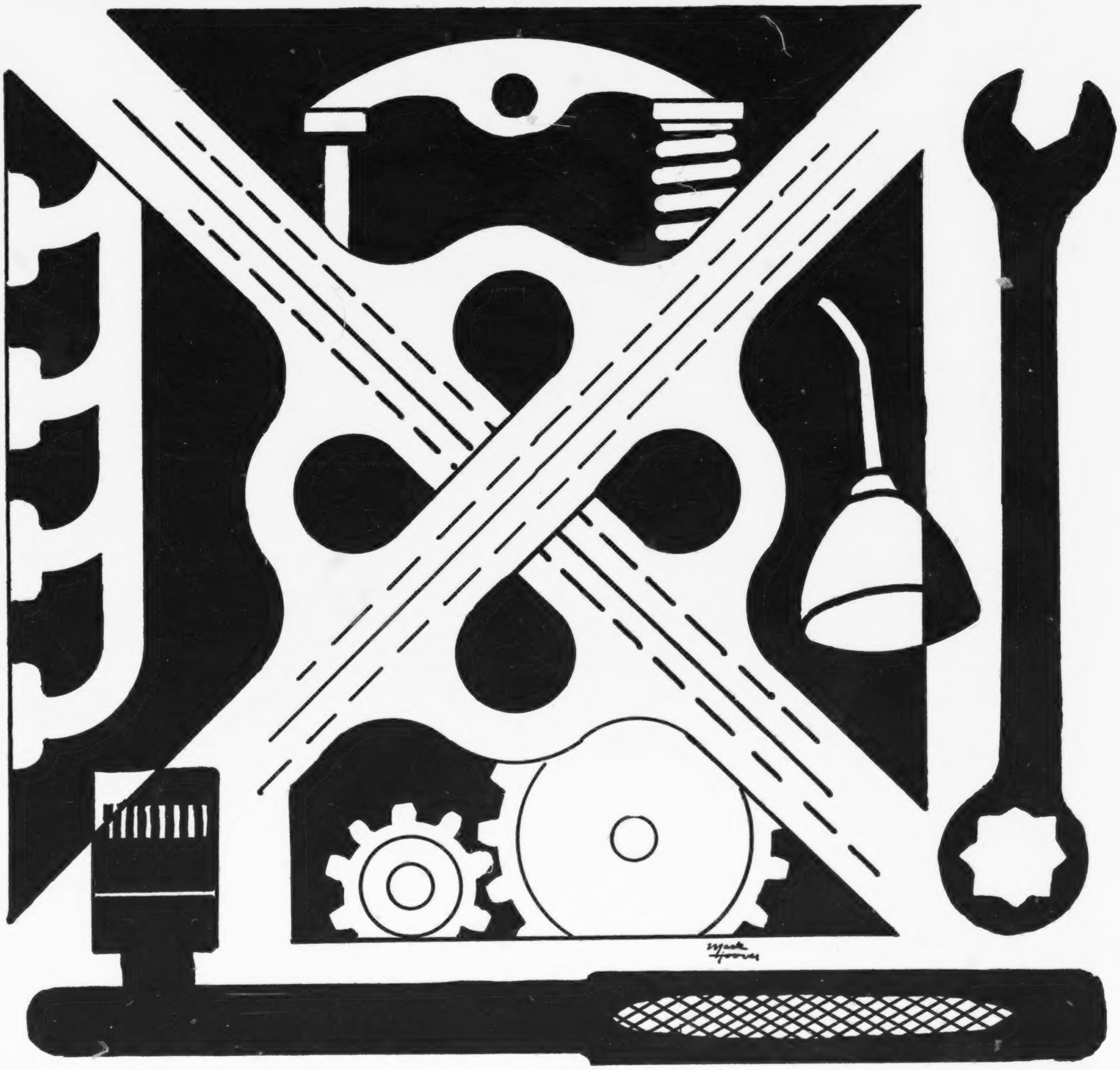
POWER MECHANICS



CHAPTER XV

POWER MECHANICS

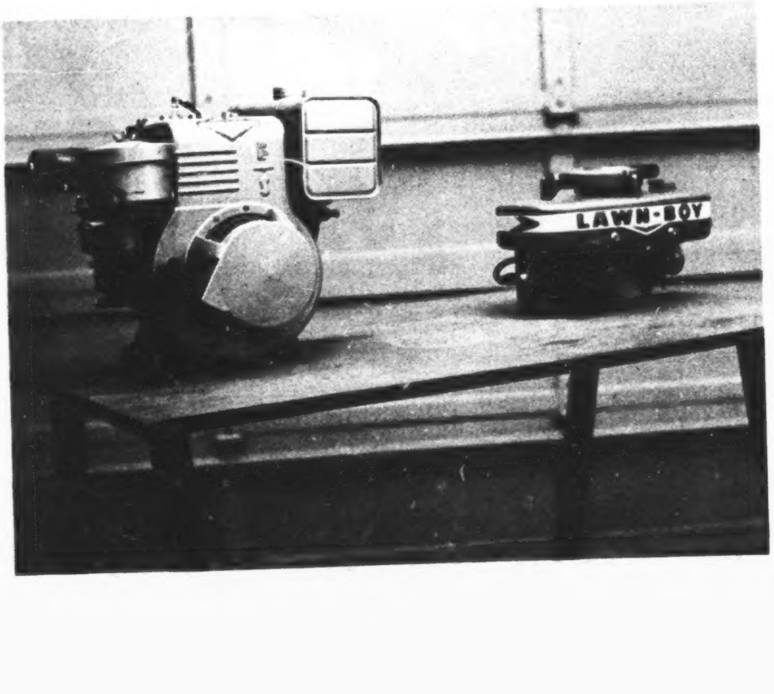
The objectives of general education and industrial arts, state that the student should be given every opportunity to acquire a basic understanding of the broad fields of learning so that he may eventually find his field of interest, aptitude, and ability. Once these have been found, directed guidance helps to place him in advanced courses of study which help to prepare him for his life's work and acceptance in our modern society.

Industrial arts, to more fully realize these objectives, must offer a greater variety of courses than has been the accepted trend. Nearly every junior and senior high school offers courses in woodworking which are acceptable for teaching skills, consumer knowledge and a vocational interest. When one studies the opportunities for life's work, we will have to admit that woodworking alone does not meet the objectives of general and industrial arts education.

There is an increasing need for power mechanics to be taught in the junior high school general shop, as well as in senior high. The unit is designed to acquaint the student with the basic concept of power progressing into the fundamentals of typical power units accessible to them. The shop work that is possible in this unit can enrich the learning units with both experimental and vocational type experiences.

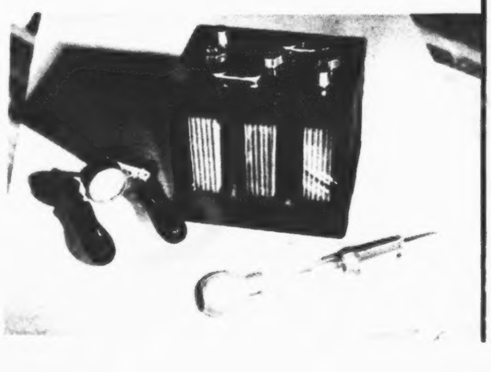
Power mechanics, as a general field, has been more instrumental in the development of today's industrial might than has any other single industry. The small power unit and the automobile are special interest areas in the field of power mechanics, but of equal interest is the history of power along with research on modern power sources. To give a realistic view of the power mechanics field, all sources of power should be considered from conception to utilization.

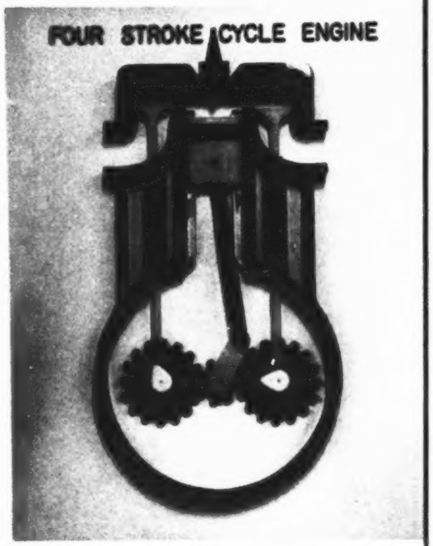
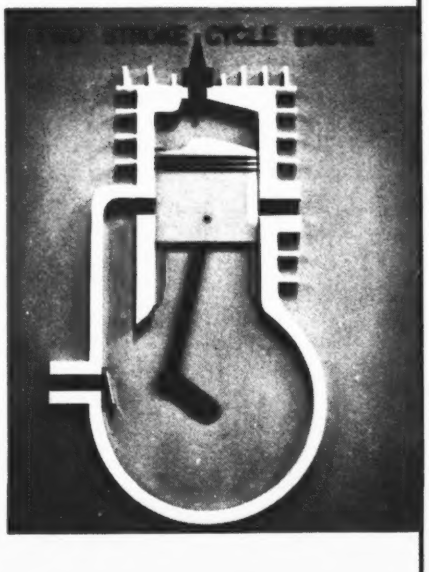
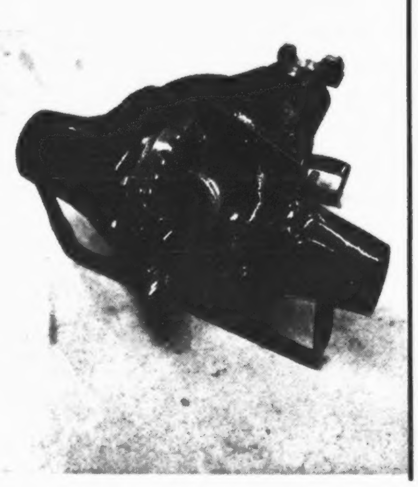
Power mechanics is adaptable to almost any phase of the industrial arts program. Its teaching should follow logically units in drawing, metals and woodwork because these areas help to establish fundamental operations beneficial to the completion of suggested units of learning. Power mechanics lends itself well to intergration with other courses in the school. General science, history, and mathematics are directly related, while a vocational interest, consumer knowledge and pre-vocational skills are other aspects of the course.

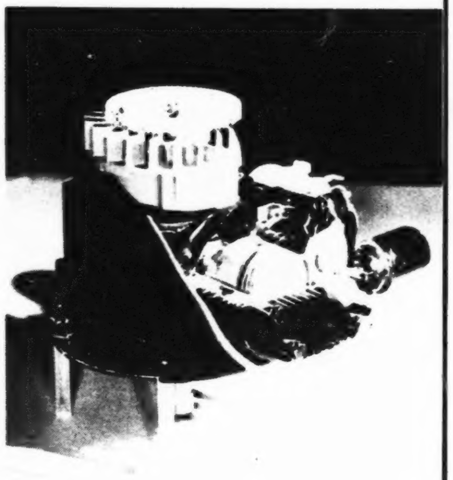
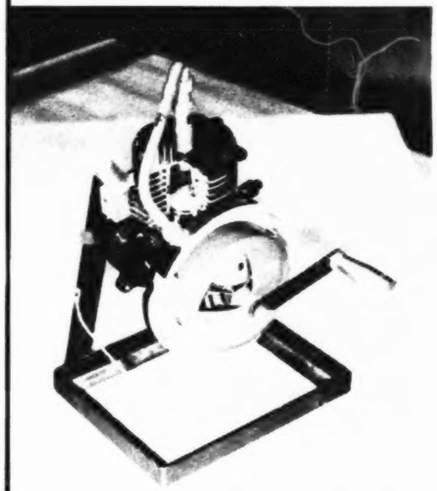
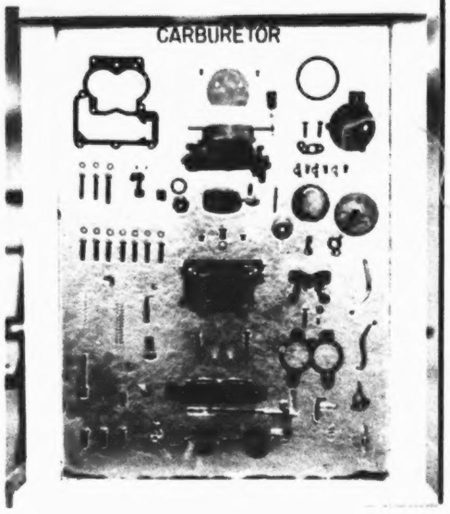
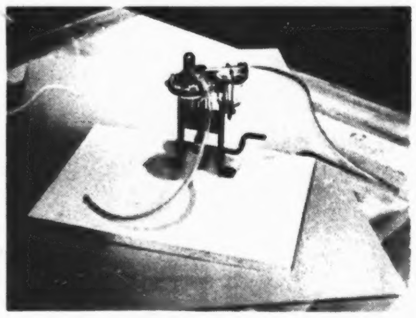


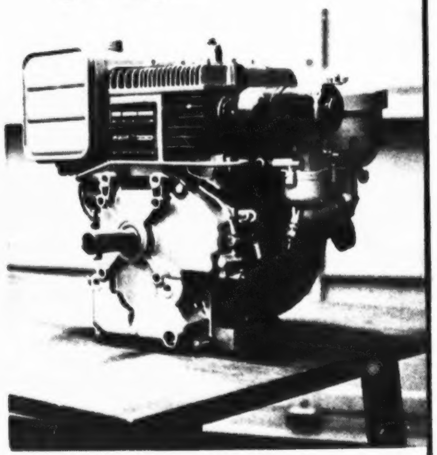
POWER MECHANICS

Safety must be stressed within all of the following learning units in power mechanics.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
General safety	General shop safety Attitude, work habits, dress and behavior First aid	Safety equipment Color code Accident reports	
History and development of power	Human power Animal power Wind power Water power	Human power and the pyramids of Egypt Animals as sources of power: elephants, oxen, camels, dogs, mules, and horses Windmills and sailboats Water wheel to hydroelectric	Books: 66, 44 Other Resources: 156
Applied physics of work, energy, and power measurement	Definition of work Force X distance Potential energy Kinetic energy Efficiency Horsepower	Formulas and problems in applied physics	Books: 66, 54, 81
Simple machines	Levers Wheel and axle Pulley Inclined plane Screw Wedge	Application of simple machines in mechanical mechanisms and devices Mechanical advantage	Books: 48, 67, 46 Film: 139
Electricity 	Electron theory Electricity flow Conductors and insulators Circuits and magnetism Electrical production, chemical and mechanical Electrical measurement Semiconductors	Ohm's Law Kinds of conductors Kinds of insulators Kinds of cells and batteries Methods of generation Application in industry Uses of semiconductors and their composition	Books: 2, 81, 48, 42 Films: 93, 97, 99, 100, 106, 119, 112 Other Resources: 155

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Engine types  	Steam engine Steam turbine Two stroke cycle Gas turbine Diesel Jet and rocket Experimental engines (rotary, free piston, omega, cam engine, etc.)	Operating principles Applications of engine types; I-head, F-head, and L-head types Variations of basic engine types	Books: 5, 73, 82, 90, 91, 76, 72, 44, 76 Films: 101, 102, 120, 124, 125, 126, 127, 131, 137, 140 Other Resources: 156
Power transmission and application 	Mechanical Hydraulic Pneumatic Electrical Basic formulas in power transmission Propulsion	Gears, clutches, belts, pulley, etc. Hydrostatic drives Hydraulic fluids, cylinders, and pumps Compressors and pneumatic equipment Electrical power transmission	Books: 44, 46, 62, 63, 81 Film: 102 Other Resources: 156, 149

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Engine construction 	Major parts and assemblies Relationship between parts and tolerances Standards for bolts, nuts, and screws	Metals and problems encountered in designs	Books: 73, 66, 91, 69 Films: 98, 101, 135, 137 Other Resources: 156 
Ignition systems	Magnetos Battery ignition (coil, distributor, breaker points, condensor) Spark plugs and ignitors Electronic ignition Principle of compression ignition	Manufacturing and industrial production Personnel employed Electricity in ignition Generators, alternaters, and batteries Kinds of spark plugs	Charts Books: 5, 48, 82, 35, 36, 45,91, 32, 34, 40, 81 Films: 97, 99, 100, 112, 116, 121, 126, 140, 141, 94 Other Resources: 156
Fuel systems and carburetion 	Fuel storage, fuel pumps, and injection systems Carburetors and carburetion Gravity flow systems Suction feed systems Fuel mixture and combustion 	Petroleum refining Types of fuel Chemistry of fuels and combustion	Books: 4, 11, 13, 3, 60, 24, 47 Films: 92, 95, 96, 103, 104, 107, 129, 133, 134, 138 Other Resources: 156, 157

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Cooling systems	Water cooling Air cooling Heat and heat transfer Cooling system design	Antifreeze Water pumps Radiators, thermostats, and cooling fins	Books: 2, 54 Films: 105, 115, 142, 143 Other Resources: 149, 156
Lubrication and bearings	Oils, greases, and other lubricants Bearing types (ball, insert, roller, needle) Bushings, piston rings, and lubrication systems (pump, pressure and splash)	Types of lubricants Oil filters and types of oil pumps S A E grades Additives Oil viscosity, ML, MM, MS Application of bearing types Friction	Books: 4, 21, 25, 26, 27, 28, 54 Films: 98, 96, 107, 129, 130, 132 Other Resources: 149, 156
Preventive care and maintenance of small gas engines	Care of fuel filter and air filter Engine lubrication Preparing for storage Preparing for use after storage Check wiring	Action of hydrocarbons in fuel and effect when exposed to oxygen Consumer knowledge	Books: 54, 35 Film: 117 Other Resources: 149, 156
Servicing and trouble shooting the small gas engine 	Servicing magneto Spark plugs Carburetor and governor Adjust ignition timing Engine tune-up Compression check Valve adjustment	Types of tune-up equipment Methods of gauging and measuring Interpret readings	Books: 54, 81, 58, 80 Films: 99, 106, 111, 117, 94 Other Resources: 149, 156
Atomic power	Atomic materials Atomic reactors Atomic fission Heat exchangers Proposed uses of atomic power	Nature of matter Radiation and Isotopes Albert Einstein and fission Chain reaction Uranium-graphite pile Mining and processing of uranium	Books: 50, 53, 67, 77, 5, 48, 82

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Solar energy	Most types of energy trace back to solar energy Solar cells Applications of solar cells Solar battery Semiconductors Thermopile Photogalvanic cell	Organic fuels from solar energy Photosynthesis Solar energy and the weather Direct use of solar energy	Books: 48, 82, 67
Experimental modern power	Fuel cell Thermionic Magnelohydrodynamic (MHD) Thermoelectric Thermophotovoltaic (TPV) Piezoelectric effect	Chemical energy to electrical energy directly Heat energy to electrical energy directly	Books: 82, 67, 55

AUTO MECHANICS

A course in auto mechanics must satisfy the objectives of general education which stress exploratory experiences in breadth and, at the same time, provide basic experiences for pupils who feel the need to continue their concentration in mechanics with pre-vocational objectives in mind. The first part of this course has been prefixed with an asterisk (*), which indicates it to be basic and exploratory in nature. This portion of the course should be made available to all students, boys or girls, who wish to acquire a general knowledge of the subject field.

The second part of the course, those operations not prefixed with an asterisk (*), is designed to accommodate the student who feels the need for pre-vocational experiences. The operations and skills are specific and limited to a typical vocation rather than broad and general. The student who enrolls in this course should be desirous of pre-vocational skills and will therefore be selective in that it is designed for non-college bound.

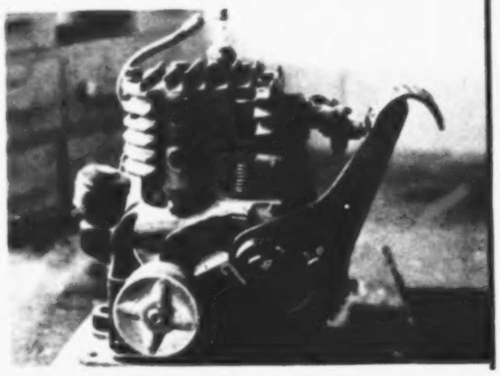
Certain concepts of power mechanics should be acquired by the student before he enrolls in auto mechanics. If power mechanics is taught in a school, then it may be desirable to omit the basic operations listed under auto mechanics that are prefixed by an asterisk. If a course in power mechanics is not available, then it is recommended that all portions of auto mechanics be taught for a concentration in the mechanics field.

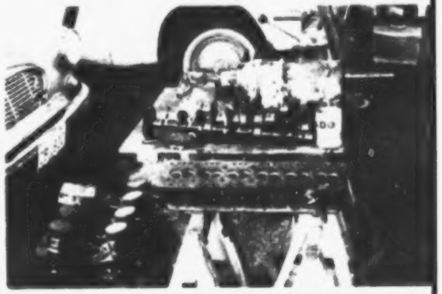
Both the basic (*) and specific portions of auto mechanics are designed to require one full year of instruction and laboratory experience. Time allowed should not be less than five periods per week in either daily or block programming.

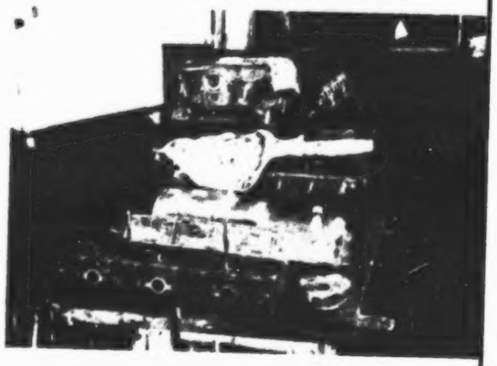
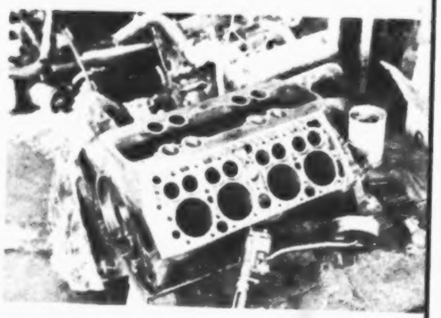
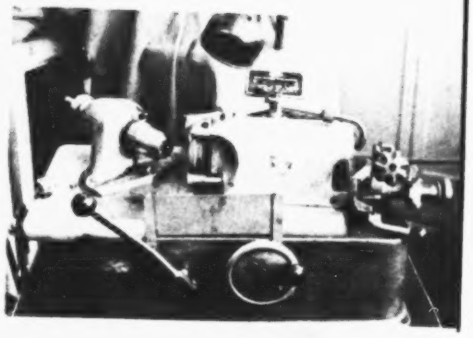
Suitable texts are listed in the bibliography; one should be selected as a course book and augmented with suitable mock-ups, manuals, commercial publications, and films. A considerable number of field trips should be arranged for the students to aid them in acquiring knowledge about machine and tool operations where schools have a limited supply of special tools.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Basic and special hand tools	General and specific uses of tools	Meanings of torque tolerance and stresses Vocabulary and safety	**Books: 68, 20 Film: 136 Other Resources: 154
*Electricity and magnetism	Electron theory, magnetism and its applications in starting, generating and ignition systems	Consumer knowledge, Ohm's law, Henry and Faraday's magnetic induction Insulators, conductors, resistors, safety, chemistry and vocabulary	Books: 2, 14, 18, 20, 23, 33, 34, 36, 37, 38, 39, 40, 41, 45, 66, 52 Films: 99, 101, 106, 119, 141, 93 Other Resources: 155, 156
*Small unit, service—electrical	Starters, generators, ignition, and accessories	Consumer knowledge, read and interpret color codes and instructions Service industry and related fields, motor bikes, scooter, etc.	Books: 18, 20, 2, 90, 51, 53, 57, 67, 70, 79, 85 Films: 99, 101, 106, 119, 141 Other Resources: 155, 150

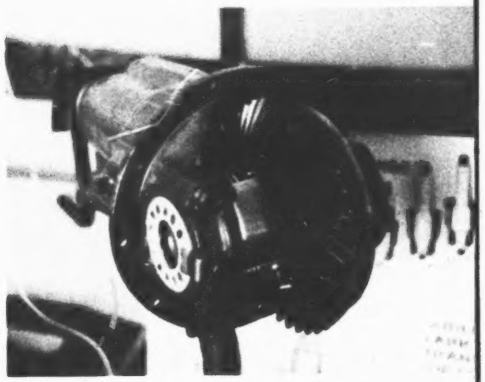
*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Small unit, service—fuel	Fuel flow, pumps, filters, lines, tanks, and carburetors Disassembly and check, assemble and test	Related industry, small power units and consumer knowledge Fuel industry, basic science and safety	Books: 3, 11, 12, 13, 24, 47, 66, 70, 72, 90 Films: 103, 104, 134 Other Resources: 149, 152, 161, 148
*Steering systems service	Check and adjust steering gear, linkage, bearings, wheels, and tires	Related industry, small power units and consumer knowledge Power assists, vocabulary and science	Books: 8, 9, 20, 21, 31, 25, 30, 66, 80, 83, 26 Film: 122 Other Resources: 149, 157
*Brake systems service	Master cylinders, wheel cylinders, lines, and hoses Service and repair, flush to clean, install new fluid, replace and adjust linings Pascal's law for hydraulics	Basic science, co-efficient of friction Interpret readings, consumer knowledge, safety and vacuum power assists	Books: 20, 55, 56, 31, 66, 73, 77, 80, 87, 74 Other Resources: 149, 157
*Standard transmissions and drive line service	Disassemble and check, service, reassemble and check Service standard disk clutches	Basic science and related industries pertaining to small power units Interpret readings	Books: 20, 61, 65, 66, 80, 83, 62 Other Resources: 149, 157
*Differential service	Disassemble and check, service, reassemble and check Final drives for small power units	Basic science of gear ratios Small power units and related industries	Books: 20, 42, 65, 83 Other Resources: 149, 157
*Engine types 	Two-stroke and four-stroke cycle internal combustion small gas engines and auto Construction, lubrication, valve types, etc.	Related industires, outboard and other small units Engine types and uses of metals; meaning of horse power and torque	Books: 5, 12, 19, 57, 60, 67, 70, 72, 78, 81, 84, 90 Films: 120, 125, 126, 127, 131, 101 Other Resources: 149, 157

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Preservice engine checks	Use of tune-up and checking equipment Evaluate preservice checks on auto and small gas engines	Related industry, types of tune-up equipment Interpret readings, consumer knowledge	Books: 20, 18, 23, 33, 34, 36, 42, 53, 65, 79, 80, 90
*Engine service 	Service and check cylinder heads, blocks, manifolds, connecting rods, rings, valves, lifters, crankshaft and bearings, timing gear or chains, oil pump, etc. Methods of cleaning, specifications and tolerances	Science of construction, metals used, consumer knowledge, related industry, methods of gauging and measuring Interpret reading, vocabulary and safety	Books: 5, 19, 20, 22, 53, 64, 72, 83, 90 Films: 111, 99, 135 Other Resources: 149, 157
*After engine service	Tune-up and evaluate result of service Readjust necessary items, practice proper break-in procedures	Consumer knowledge Follow-up on all units of study Safety	Books: 1, 65, 83
Tools and equipment	Review special tool uses in the automotive service trade	Service industries and consumer knowledge	Books: 20, 19
Tune-up and preservice checks	Review methods of locating trouble and keeping up with latest developments, interpret and evaluate tune-up data	Consumer knowledge, research in industry	Books: 20, 33, 23, 34, 47, 65, 83 Other Resources: 145, 149, 153, 156, 158
Automobile engine removal	Procedure to follow while removing accessories from the engine and removing the engine from the chassis	Interpret instructional readings Trace wiring color codes, chain hoists, safety	Books: 65, 20, 83 Other Resources: 145, 149, 153, 156, 158

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Engine disassembly 	Procedure to remove manifolds, heads, pan, pistons and rods, vibration dampener, timing gears, clutch, crankshaft, camshaft, oil pump, etc.	Measuring devices used in service checking, keep abreast of industry, safety, economy, and consumer knowledge	Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158
Cylinder service 	Check cylinders for ridge, taper and out of round, bell-mouth, etc. Remove ridge, hone, rebore or replace sleeves	Types of gauging devices used for cylinder bore checks Abrasives and uses in industry, for safety	Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158
Crankshaft and main bearing service	Clean, check with a micrometer, check for bent shaft between centers using a dial indicator, install and check bearing fit	Portable crankshaft and stationary cylinder grinders used in industry Metals used in bearings and recommended clearance, crank design and balance	Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158
Piston and connecting rod service	Cleaning, checking pistons, ring grooves, pin fit and rod alignment Methods of reconditioning pistons and rods	Industrial use of pin hones, knurlizing pistons, etc. Science of metals used in rods, rings, and pistons	Books: 20, 65, 83 Other Resources: 145, 149, 156, 153, 158
Valves, guides, lifters and camshaft servicing 	Remove and check valves and guides, cylinder heads or block, ream or replace guides, grind valves and seats, check springs, clean and assemble Check cam lobes for wear, check bearings and replace if necessary	Interpret readings for testing and servicing; metals used and why; safety and consumer knowledge	Books: 20, 65, 83, 27 Film: 108 Other Resources: 149, 157, 145, 153, 156, 158

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Lubricating and cooling system service	Remove, clean block and replace soft plugs, water jacket direction nozzles, or tubes Check, clean and service oil pump and relief valve	Related oil and antifreeze industries Basic science and consumer knowledge	Books: 20, 65, 83 Films: 96, 105, 107, 133, 142, 143
Engine mounts	Check and service	Types of mounts and why used	Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158
Assemble engine and accessories, install in vehicle	Reassemble all parts and check for proper clearance and run-out of crankshaft, flywheel and housings Install, torque to proper amount	Interpret installation procedure for gaskets and sealing materials used Torque wrenches and types used and why	Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158
Break-in and final tune-up of engine	Pre-road tune-up checks Road-test driving and and proper breakin procedure	Safety on the highway Evaluation of experience acquired and of job done	Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158
Standard transmissions, overdrives and automatic transmissions	Disassemble, clean, check, reassemble and check a standard transmission Make minor adjustments on an automatic transmission bands and linkage	Keeping abreast of industry Science of gears, ratios and types, consumer knowledge and safety	Books: 20, 65, 83, 61, 62 Other Resources: 149, 165, 145, 153, 156, 158

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Differentials and axles 	Remove, service and check differentials Service rear axle and tracking	Keeping up with industry, consumer knowledge Safety and metals used	Books: 20, 65, 83 Other Resources: 149, 165, 145, 153, 156, 158
Steering and front end alignment 	Minor adjustment and service checks on linkage, steering knuckles, ball socket or king pins and steering gears	Keep up with industry, consumer knowledge, safety, front end geometry and hydraulic power assists	Books: 20, 65, 83, 7, 8, 9 Other Resources: 149, 165, 145, 153, 156, 158
Brakes	Minor and major adjustment for all types of brakes and power assist units Lining types and coefficients of friction for each	Basic science, consumer knowledge, related industries, and safety	Books: 31, 55, 56, 66, 73, 74 Other Resources: 144, 145, 149, 153, 156, 158, 160
Chassis or frame, body and fender repair and refinishing	Service doors, windows, body and fender Rebuild rusted out sections or fill, paint, reupholster, straighten frame and operate spray equipment	Related service industries: cloth, glass, plastic and metals Safety and consumer knowledge	Books: 7, 8, 9, 10, 20, 65, 83, 31 Other Resources: 145, 149, 153, 156, 158

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158. Studebaker-Packard Corporation, Automotive Shop Manuals, South Bend, Indiana, 635 South Main Street.

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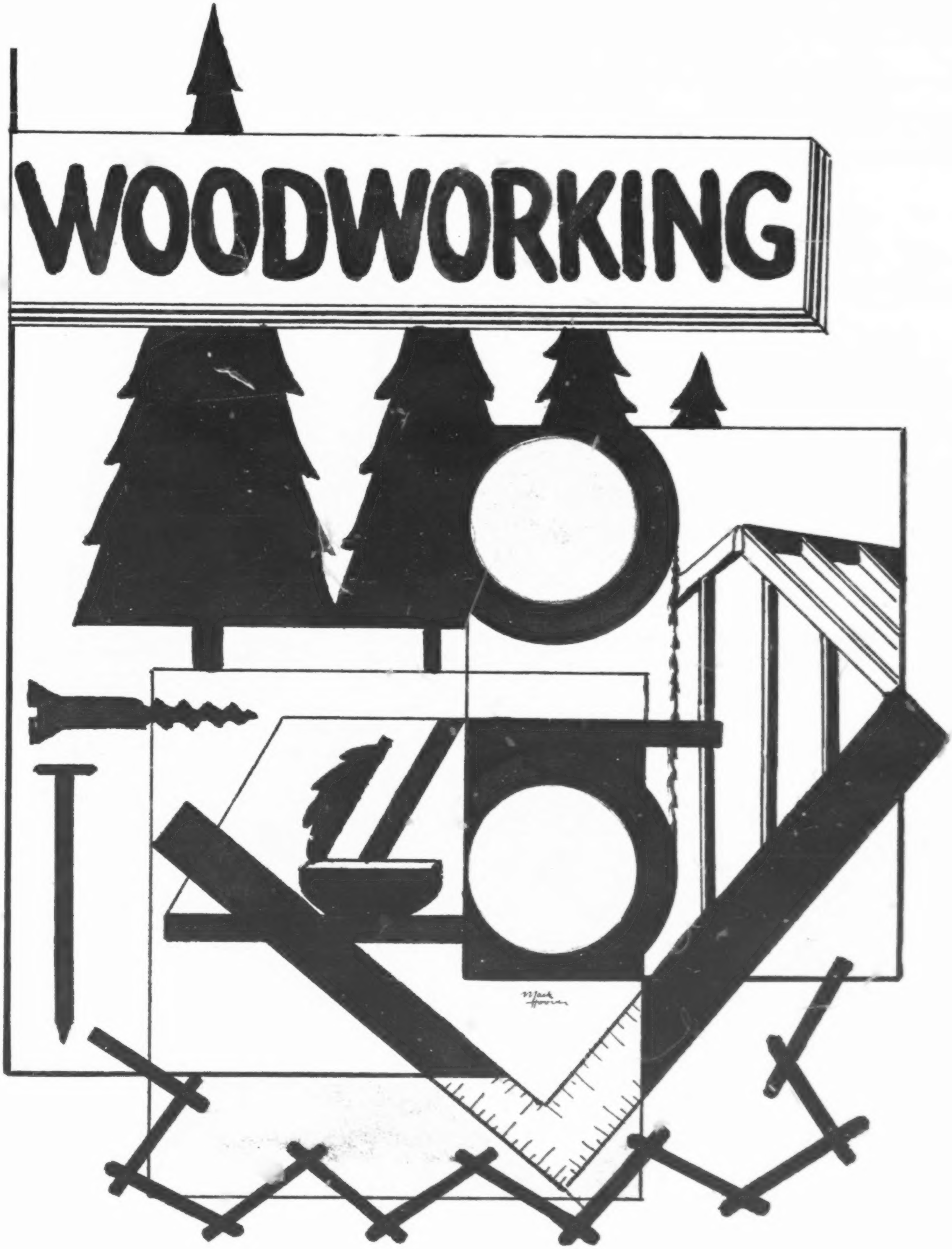

WOODWORKING

CHAPTER XVI

WOODWORKING

Wood is one of the most common materials known to man. It has been used for centuries and today constitutes a major factor in the home and office for utilization and beauty, and in industry and manufacturing as a raw material. Among the occupational categories of the woodworking industry that can be represented in industrial arts shops are: milling, carpentry, cabinet making and pattern making. The closely allied phases, such as upholstery, model making, stagecraft, and wood finishing should be included.

BENCH WOODWORKING

The woodworking industrial arts program is a part of general education offering exploratory and enrichment opportunities. When offered at the junior high school level in either a general or unit shop, it should be required of all 7th and 8th grade boys and offered on a selective basis thereafter.

In a bench woodworking shop, equipment should be available for both planning and instruction in handtool work, carving, finishing, carpentry and upholstery.

At the junior high level or any beginning level, stress should be on handtool operations with the possible use of the jig-saw, drill-press, and grinder. Emphasis also should be on safe working practices, the importance of following a set of orderly procedures, and the need to develop a certain degree of skill in handling tools and materials.

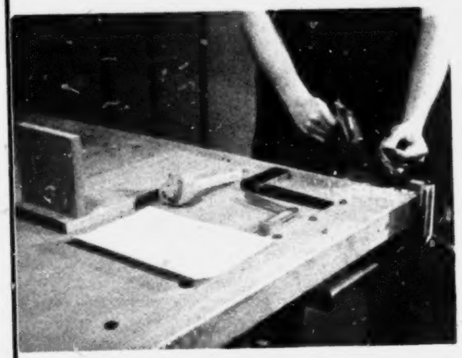
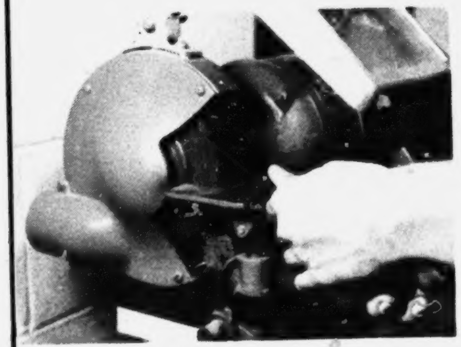
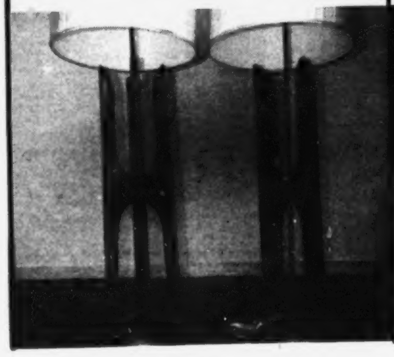
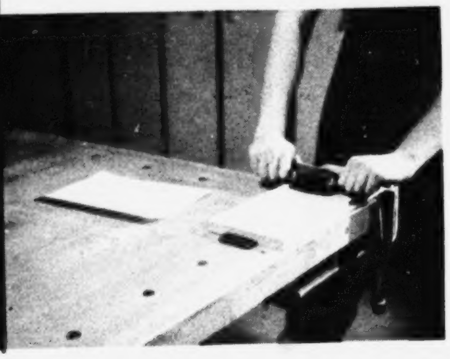
In any woodshop class, especially at the junior high level, the value of films and demonstration should not be overlooked. It is difficult to give an overall view of all the various phases of the woodworking field in the school shop and, as a result, field trips are often a valuable aid in providing a better understanding of the wood industry. Some areas of learning can be covered by film allowing for a close-up of operations that would be difficult to observe even on a field trip. Films may be utilized when teaching in areas such as lumbering, milling, manufacturing of allied products and the like. Demonstrations of operations considered too dangerous for junior high pupils can be given to give them an idea of things to come as they gain in experience and maturity.

BENCH WOODWORKING

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
		Classification, properties and uses of common woods	Samples — finished and unfinished

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
		Lumbering — *standard dimensioning and grading	**Models of grain pattern 86, 72, 90
		*Plywood — its manufacture and uses	Charts and samples
*Selecting or designing a project	Making a sketch or working drawing	*Orthographic projections *Pictorial sketches Making templates and geometric layouts	Magazines Mail order catalogs 22, 44, 55, 59
*Make a materials list and plan of operations	*Read a working drawing *Figure board and square measure		11, 19
*Laying out the project	*How to use rules and squares *How to use marking tools *How to use gauges *How to use templates	*Types of rules *Types of gauges *Types of squares *The compass, dividers, and trammel points	Models 58, 98
*Cutting with hand saws	*How to identify and use the cross-cut and rip saws *How to saw holes and curves *How to use the miter box How to use the back saw	*Types of and uses for hand saws How to fit hand saws	Enlarged models of saw teeth 67, 70, 88, 91, 94, 98

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Selecting and using hand planes	*How to assemble and adjust hand planes How to sharpen plane blades *How to square stock to size with a hand plane *How to use a router plane How to use a rabbet plane	Types of bench planes Types of and uses for special planes	Models 81, 88, 98 
*Cutting with chisels	*Sharpening chisels and gouges *Paring end and cross grain Shaping with gouges Decorating surfaces with veining tools Making a stop chamfer with a chisel Cutting a mortise Cutting curved edges with a chisel	Types of chisels and gouges Types of hones, their uses and care	Models 88, 98 7, 88, 98 
*Smoothing curved edges	Smoothing: *With a draw knife *With a spoke shave *With a rasp and file *With abrasive paper on shaped blocks With a circular plane With a chisel *With a scraper	*Types of files and rasps The file card and its use 	7, 88, 98 

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Boring holes with wood bits	*How to sharpen wood bits *How to stop bore *How to counter bore *Through boring with counter block How to use the "screw mate" How to adjust and use the expansive bit How to use the hole cutters	*Types of wood bits Types of stops Types of braces and drills	7, 74, 98
*Fastening with screws	*How to select bits when boring for screws *How to select the proper screw *How to sharpen and use a screwdriver How to cover screw heads	Kinds and sizes of screws Reading the screw chart *How to select the proper screw driver	Models, 7, 76, 87, 98
*Fastening with nails and other fasteners	*How nails are sized *How to drive and draw nails *How to use the nail set *How to hide or cover nail heads	*Types of nails and their uses *Types of nail hammers Corrugated fasteners Clamp nails	Charts 7, 97
*Construction of panels and accumulated stock	*Matching grain *Constructing the joint *Adjusting and positioning the clamps *Truing the surface and planing to thickness	Types of clamps and their uses *Types and uses of glue	Models 7, 73, 77
*Construction of joints	*Lay out and construct *simple butt, *dado, *middle lap, *cross lap, *simple miter, *doweled miter, *spline miter, feathered miter		7, 73, 77
*Application of hardware	How to install: surface hinges, butt hinges, concealed hinges, semi-concealed hinges, chest hinges, table hinges,	Types of hinges and their uses Types of pulls Types of catches and locks	Catalog 7

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
	spring leaf supports, shelf standards		
*Preparation of the surface for finishing	*Removing dents, *scraping with hand and cabinet scrapers, *sharpening scrapers, *using abrasive papers, *glazing-shellac etc., sponging "whiskers"	*Types of scrapers *Finishing abrasives Types and uses of bleaches; types and uses of glazing compounds	Models 64, 65, 68, 94
*Finishing	*Wood stains *a. Water *b. Oil *c. Spirit *d. Non-grain raising *Wash coats *a. Shellac *b. Lacquer base *Fillers *a. Paste *1. Silica *2. Zinc oxide *Sealers *a. Shellac *b. Lacquer sanding *c. Penetrating *Finishes *a. Clear *1. Varnish *2. Lacquer *3. Synthetic *b. Opaque *1. Varnish-enamel *2. Lacquer *3. Paint		54, 62, 82, 94

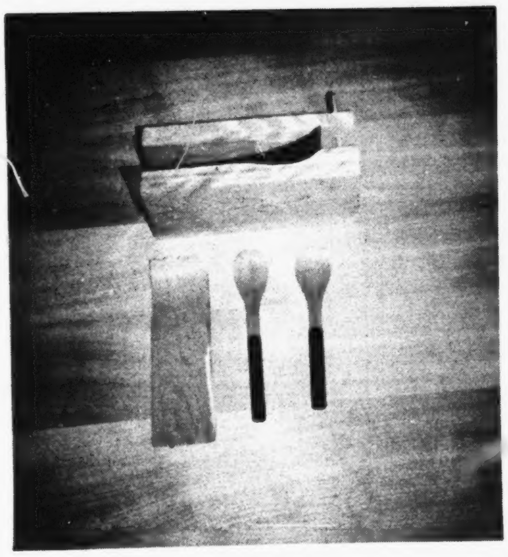
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
*Finishes	*Rubbing and abrasive materials *a. Dry *b. Abrasive papers and cloth *c. Paste *d. Steel wool *Vehicles and thinners *a. Linseed oil *b. Tung oil *c. Synthetic oils *d. Turpentine *e. Mineral spirits *g. Lacquer thinner Selecting and caring for brushes	Production of shellac Manufacture of paste fillers Natural and synthetic gums and resins Manufacture and use of brushes Manufacture of vegetable oils and their uses	54, 62

Projects — Bench Woodwork

Projects should be selected by the student and teacher and should meet the objectives of the course. Suggested projects are:

Suggested projects:

Book racks
Book ends
End tables
Coffee tables
Book shelves
Night stands
Lamps
Drawing tables
Gun racks
Typing table



MACHINE WOODWORKING

The machine woodworking program should be an area of emphasis available to all industrial arts programs. Organize the program so that instruction in hand and machine woodworking can be offered in the same shop area. This will allow efficient utilization of facilities and space. Along with hand and machine operations, such areas as carving, finishing, carpentry, cabinetry and upholstery should be offered.

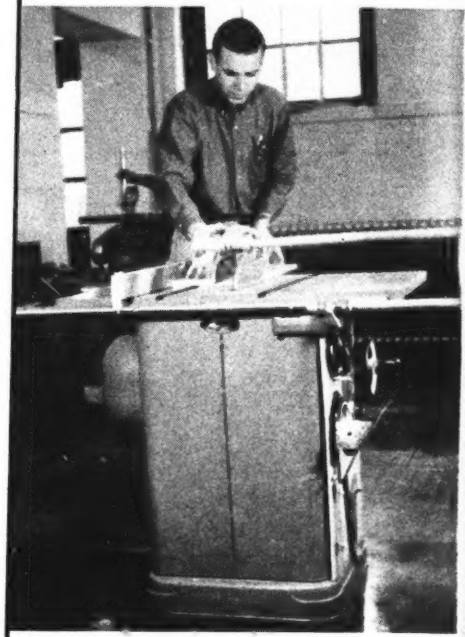
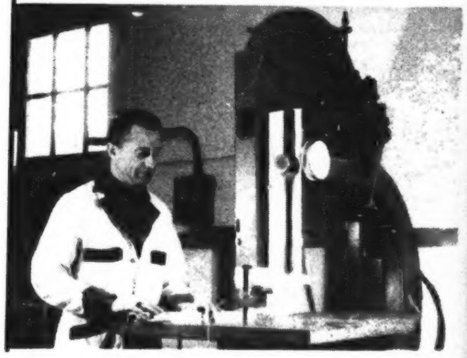
Safety in the care and use of equipment must be emphasized to provide effective growth and development in machine operation.

Bench woodworking should be considered a prerequisite for machine wood, in which basic skills and techniques are emphasized. Draw relationships to machine operations in the beginning course to show how these skills provide the foundation for further development. Three units of instruction should be provided in this area: bench wood, beginning machine woodwork, and advanced machine woodwork in the senior high school. Any instruction beyond this level should be vocational in nature.

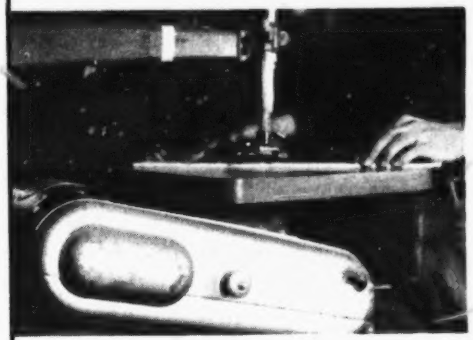
The use of films and other audio-visual aids is an effective method of instruction as well as a means for showing industrial processes. Present the relationship between industrial arts and industry to show the importance and potential in this area of instruction.

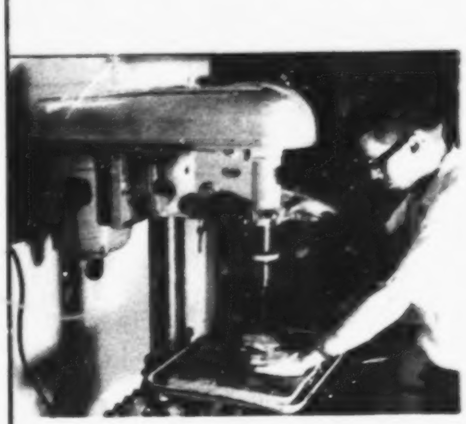
Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Employment	Opportunities Requirements for woodworking trades Large and small company organization College opportunities	Wages Union organization Non-Union Contracting Apprenticeship	Employment office charts, statistics, etc. Unions Bulletins General information
Lumber and machining	Common classifications of lumber Methods of sawing Grading Terms Method Machined sizes	Hardwoods Broad leaf Softwoods Evergreen or cone bearing Circular saw Band saw First and second grades Selects Commons, Numbers 1, 2, 3, 4, and 5 Shop Standard thicknesses of stock S1S S2S S4S Random lengths, widths	**23, 79, 86 72, 75, 90, 97
Plywoods	Types Hardwood Softwood Interior Exterior Veneer core Lumber core Particle board Hardboard	Manufacture and construction characteristics of this area Grain patterns available Plain slice Flat slice Quarter slice	92, 93, 97

** Check reference numbers at end of unit

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
Selecting, designing and planning	Distinguishing characteristics of period furniture Trends in design and construction Factors that influence design Modern design and new materials Know and understand design for construction Selection of materials Produce a work drawing Establish construction procedure	Discuss and show examples of period furniture Types and characteristics of wood for use Names of designers	36 10, 22, 25, 38, 44, 47, 71
Circular saw	*Remove and mount blades *Ripping and crosscutting *Adjusting and using guards *Cutting grooves, rabbets and gains *Dado head use *Stop block cutting *Cutting angles and bevels Cutting tongue and groove joints Cutting tendons and mouldings Tapering Cove cutting Molding head	Safety Sizes Parts Mechanical adjustments Care and maintenance Types Adjustable table Tilting arbor Variety Universal Power feed Hand feed Blades Types Kinds Brands Jigs	Machine company instruction manual 24, 51, 67 
Band saw	*Cutting curves *Duplicate part cutting *Sawing with paterns *Adjusting the machine Changing blades Taper cutting Sawing disks and segments	Safety Sizes Parts Mechanical adjustments Care and maintenance Sharpening blades Brazing blades	Machine company instruction manual 24, 51, 66 

*Identifies areas applicable to general shop.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Scroll saw	*Scroll cutting *Adjusting machine Saber blade sawing Angle sawing Marquetry work Sanding and filling Blades	Safety Size Parts Mechanical adjustments Care and maintenance Speed ratios	Instruction manual 24, 66 
Portable power saws: Hand jig, saber, or bayonet saw	*Adjust and operate *Straight and irregular cutting *Plunge or internal cutting *Bevel cutting	Safety Size Parts Mechanical adjustments Care and maintenance	Instruction manual 24, 66, 96
Jointer	*Adjusting the table and fence *Adjusting and using guards *Jointing and edge *Squaring stock to size Surfacing Tapering (stop and full) Rabbeting Beveling and chamfering Tenons	Safety Size Parts Mechanical adjustments Care and maintenance Principles involved in jointer operation	Instruction manual 24, 51, 67, 77
Drill press	*Adjustments *Boring holes Mortising Routing	Safety Size Parts Mechanical adjustments	Instruction manual 51, 69

Units of Instruction	**Fundamental Knowledge**	**Related Information**	**Instructional Materials**
	Shaping Sanding	Care and maintenance Speed ratios Various bits and attachments	
Portable electric hand drill	*Adjust and operate *Boring operations *Sanding operations: Drum sanding Disc sandings	Safety Size Parts Care and maintenance Types of bits Twist Power screwdriver Masonry	Instruction manual 51
Sanders and polishers	*Sander operations: Flat Curved *Adjustment *Changing abrasive	Safety Size Parts Mechanical adjustments Care and maintenance Types: Pad Orbit Straight stroke Portable belt Disk Stationary belt	Instruction manual 62, 64
Routers	*Shaping edges *Rabbeting *Trimming laminates Making joint cuts: Dovetail Rabbet Dado Grooves Freehand routing Veinning and fluting Templete or pattern cutting Cutting recesses	Safety Size Parts Mechanical adjustments Care and maintenance Variety of cutters	Instruction manual 84 Company chart of cutters

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Wood lathe	*Uses of the lathe *Turning tools *Spindle turning *Face plate and chuck turning Finishing on lathe Parts of the lathe	Safety Size Mechanical adjustments Care and maintenance Types of lathes Speed ratios	Instruction manual and charts 39, 78
Grinder	*Dressing wheels and stones *Sharpening plane irons and chisels *Sharpening scrapers Sharpening wood turning tools Sharpening carving chisels, gouges Sharpening drill bits Knives Saws: Hand Machine Jointer blades Planer blades - Shaper cutters	Safety Size Parts Mechanical adjustments *Care and maintenance* Kinds of grinders Types of grinding wheels Speeds How grinding wheels are sold: Grades and bonds Sizes Current prices	Instruction manual 64, 98 Catalogs
Planer or surfacer	Setting and operating Squaring stock Squaring duplicate pieces Surface stock to thinness Cut narrow pieces to width Surface thin stock using backing board Adjust and control feed Feed work into machine	Safety Size Parts Mechanical adjustments Care and maintenance Safety speeds of feed	Instructional manual 9, 51

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Shaper	*Understand principles of cutter head operation Adjustments Cutting grooves and rabbits Shaping a straight edge and curved edge Fluting and reeding Shaping with patterns	Safety Size Parts Mechanical adjustments Care and maintenance Cutter types: Clamp type 3 lip cutters	Instructional manual 84
Mortisers	Setting and using Using drill press attachments Set and adjust chisels and butts Feed work Make set up for duplicate parts	Safety Size Parts Mechanical adjustments Care and maintenance Range of work which may be done Types	Instructional manual 9, 51
Radial arm and swing saws	Adjust and operate Operations: Cross cut Miter cut Ripping Dado cuts	Safety Size Parts Mechanical adjustments Care and maintenance	Instructional manual 9, 51
Portable cut-off saws	Adjust and operate Straight cuts Miter cuts Bevel cuts	Safety Size Parts Mechanical adjustments Care and maintenance Different types	Instructional manual Catalogs 9, 51
Portable power plane	Adjust and operate	Safety Size Parts Mechanical adjustments Care and maintenance	Instructional manual

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Application of hardware by machine	Electric hand drill and attachments: Power screw driver Depth gauge Router Kinds and uses: Bolts Cabinet hardware Door locks Butt hinges	Materials from which manufactured How sold: Quantities Current prices	Hardware Co. charts Instruction manuals
Spray gun finishing	Catch plates Equipment used in finishing: Hand Production Heat lamps Operation and maintenance	Types of spray guns Types of air compressors Paint tanks Hoses Types of power polishers Polishing compounds	Instruction manuals 54, 62

Projects — Machine Woodwork

Projects should be selected by the student and teacher. and should meet the objectives of the course.

UPHOLSTERY

Upholstery is a unit of instruction which has received little emphasis in the instructional program. The purpose of this unit is to introduce a basic program suitable for a shop program.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Choice of materials	*Choice of materials Type Patterns Colors	Characteristics that influence life, strength, and durability of fabrics	Local upholsterer Furniture dealer **Books: 1, 2
Equipment	*Equipment Shears, 6 inch Combination hammer and tack extractor Webbing stretcher Sewing machine Button machine	History and origin of equipment and its use	Book: 1 References on upholstery
Processes	*Processes Frame construction Cutting covers and patterns	Layout methods Size Corners Pleats Overlap Welt cord	Books: 1, 2
Webbing	Application, tacking and webb stretching	Amount and location of webbing Methods of tacking and stretching webbing	
Springs	Basic springing and typing	Number and sizes of springs	Books: 1, 2

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.

Units of Instruction	Fundamental Knowledge	Related Information	Instructional Materials
Stuffing (padding)	Stuffing	Materials and methods of stuffing Cotton Rubberized hair Foam rubber Poly foam Inter spring Hand Machine	Books: 1, 2
Sewing and tacking	Sewing and tacking of covers	Types of needles, cord tacks, and twine	Book: 1
Cushion construction	Cushion construction	Layout of materials Belt Top Bottom Welt cord Zipper	Book: 1
Assembly methods	Assembly methods	Hand sewing Machine sewing	Books: 1, 2

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